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LECTURES

ON

OSTEOLOGY,

INCLUDING

THE LIGAMENTS

WHICH CONNECT THE BONES

OF

THE HUMAN SKELETON.

BY B. B. COOPER, F.R.S.
SURGEON TO GUY'S HOSPITAL, LECTURER ON SURGERY,
&c. &c. &c.

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1844.

DEDICATION

TO THE FIRST EDITION.

TO SIR ASTLEY PASTON COOPER, BART., F.R.S.,
&c. &c. &c.

PRESIDENT OF THE COLLEGE OF SURGEONS, AND
SERJEANT-SURGEON TO THE KING.

MY DEAR SIR ASTLEY,

As you were the first who pointed out to me the necessity of a work on the plan I have here adopted, and the advantages to be derived from the union of descriptive anatomy with surgical remark, I cannot refuse to myself the gratification of prefixing your name to this humble endeavour at realizing your suggestion.

The conviction with which I have been long impressed, that none but professional men can estimate professional difficulties, is another strong ground for my singling out one so eminently qualified, as you are, both to pronounce judgment and to make allowances. Whether as a teacher, an anatomist, or an operator, you have long enjoyed preeminence by the suffrages of the world; and far from seeing, in our accidental relation to each other, any cause for my withholding that tribute from you, which I should be proud to offer to the same excellence in a stranger, I do it with a deep, additional satisfaction.

I know how much, in the following pages, I have fallen short of your comprehensive conceptions; yet I am not without the hope, slender as I feel any pretension of mine, that enough of usefulness will be found embodied in them to make them not unworthy of your acceptance.

Believe me always,

My dear Sir Astley,

Your's, with unalterable attachment,

BRANSBY B. COOPER.

PREFACE.

The present work constitutes a Second Edition of the First Volume of the "Lectures on Anatomy;" which the Author has been induced to re-publish, in consequence of the large demand for that Volume rendering its reprint necessary.

In bringing it again before the public, he has taken the opportunity of making corrections, and additions; and by altering the type and paper, has been enabled to effect a considerable reduction in the price, which prompts him to send it forth in its new form, as a Treatise on the Human Skeleton.

New Street,
26th Sept. 1844.

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INTRODUCTORY LECTURE.

If the importance of a science be estimated by its utility, that which ministers to the welfare of mankind, by removing the diseases and repairing the injuries to which the human frame is liable, must be entitled to no subordinate rank. As the exercise of our profession demands a knowledge not only of the principles of that science, but of their practical application, in every case that may arise, it behoves us from a sense of honor, of interest, and of duty, to establish those principles on the most solid foundation.

The basis upon which the perfection of medical science rests, is divided into three component and essential parts, Anatomy, Physiology, and Pathology.

In the natural order and relation of things, the study of pathology must be consequent upon that of anatomy and physiology; for it is only by an accurate knowledge of the structure of the human body, and of the functions of its different organs, in a state of health, that we can determine the nature of disease, and adopt rational and judicious rules for its treatment. To ascertain the structure of organized matter, is the proper object of anatomy; that of physiology, is to define the functions of the different organs; while to distinguish diseases, and the morbid affections to which they are liable, constitutes the science of pathology. But before we proceed to consider the human body as organized matter, let us enquire into the points of affinity and of difference which it exhibits in relation to matter not organized. We find, for instance, that the human frame possesses the essential properties common to all matter, as extension, form, divisibility, inertion and attraction: hence we are led to infer, that the *animal*, *vegetable*, and *mineral kingdoms*, are but different modifications of the same elementary matter; and that, in this respect, man must acknowledge an affinity with the tree that yields to him its fruit and its shade, and with the very rock from which he hews the material for his habitation. Rightly considered, this reflection cannot be supposed to derogate from the dignity of human nature; for the modifications of matter in man, is in many respects so different, and in all so superior, that it justly entitles him to be distinguished as the noblest of created beings. He derives this distinction from a faculty, of which the superiority appears immeasurable, even when compared with the highest of those possessed by the subordinate beings.

All bodies possessing organization and life are divided into two classes, the *animal* and the *vegetable*, and which present many points of mutual affinity. They both possess the power of producing changes within themselves; both have the faculty of generating new modifications of matter during their growth and developement: thus recruiting that waste of body which is continually going on, by the assimilation of foreign matter.

These are the phenomena that constitute the great distinction between organized and inert matter: accordingly, those objects in which this inherent vital principle is found, are designated generally as *living* matter; while those in which it does not exist, are comprehended under the term *inorganic* matter: but when living matter loses these vital functions, or, in other words, when it is deprived of the power of appropriating and assimilating foreign matter into its own substance, it retains merely the essential properties of common matter, into which it resolves itself, and in that state is capable of being affected by ordinary chemical agents. These two classes, are, however, distinguished by characteristics sufficiently obvious: the animal being endowed with sensation, thought, and volition; while the vegetable is destitute of those functions.

This distinction being acknowledged, we are now to enquire on what ground man claims so high a pre-eminence above the other individuals of the class to which he belongs; and by what title he holds the distinction of being "the paragon of animals." The deductions of anatomy, though they demonstrate that he possesses properties peculiar to himself, do not sufficiently shew, that he is not only superior to all other animals, but that in fact he takes precedence of all created beings in the visible world, and ranks next to his Creator. It is not because man is erect in stature, and has two hands, that he is entitled to a separate and highly pre-eminent rank * in the animal kingdom; but because he possesses the great faculty of reason or judgment, which enables him to distinguish what is advantageous or useful, from what is inconvenient or pernicious. Self-controlled, and guided by this faculty, when he feels an inclination to possess any object, he does not obey the mere impulse of such a desire, but first considers whether the act which he meditates, of appropriating that object, be right or wrong, just or unjust: thus regulating his conduct by fixed principles, and subjecting his appetites and passions to the dictates of a discriminating faculty, with which no other animal is endowed. When this faculty is fully exerted, it raises man above the sphere of self-interest, and prompts him to aim at promoting the general advantage of his species. If this, his high prerogative, be duly considered, no argument will be required to shew that man is the master-work of the Creator's hand; and that, whatever is calculated to establish the health, augment the comfort, and improve the condition of a being so richly gifted, and so highly favored, cannot deserve to be otherwise regarded than as one of the most interesting objects of human enquiry. Such, for inscrutable purposes, is the constitution of the physical and moral world, that human life is not only precarious as to its duration, but exposed at every hour to a variety of ills, demanding all the resources of human knowledge for their prevention or cure.

Health is universally felt to be the greatest of all earthly blessings; it is, in every condition and degree of society, the sweetener of existence; with it, the poor, through industry, attain to independence, to affluence; with it, the wealthy relish the advantages of riches; without it, the peasant must struggle against penury, and die a lingering and a cheerless death; while the rich, even the monarch himself, if denied this precious boon, must feel all the refinements, the splendour, the luxury that opulence can purchase, to be merely a splendid curse; must regard even the most intellectual of all social pleasures with a weary eye; "view, undelighted, all delight;" and denounce the amenities of life. If such be the value of health, never so truly estimated as by its loss, how important a share of attention must be claimed for that science which aims at its preservation!

In this introductory address, it will be my endeavour to explain the object and bearing of this course of lectures, and to point out the best mode of acquiring a knowledge of the structure and uses of the various parts of the human body—which branch of science is designated human anatomy.

Although to acquire a knowledge of pathology and therapeutics be the ultimate object of the medical student, still it will be obvious to every one of you that these studies must be preceded by, and founded upon, a perfect knowledge of the anatomy and physiology of the human body; for it is only through these that we can determine the nature and extent of disease, and by which we can hope to adopt rational and judicious rules for its treatment. Since, to ascertain the structure of organized matter, is the proper object of anatomy, and to define the functions of the different organs, that of physiology; so, to distinguish the diseases, and morbid affections to which they are liable (as well as to remove them), is the object of pathology and therapeutics.

Having already necessarily made use of different scientific terms, I conceive it a duty imposed upon me, before I proceed further, to give you a concise explanation of them; for without their being rightly comprehended, I could not be understood.

First, of *anatomy*, which, etymologically considered, merely implies the means employed for anatomical investigation, and not the science itself. Some modern teachers have attempted to explain its meaning, by terming it the science of organization; but this also seems to me vague and indefinite, as it does not comprehend in what manner it treats of organized matter: I believe, therefore, the term will be more readily understood, by considering that anatomy is that science, which has for its object the investigation of the configuration and structure of organized bodies. As geometry treats of the forms of inorganized substances, so does anatomy treat on organized bodies: and, indeed, the parallel may be found even in the language of the two sciences; for as geometry proceeds from points, lines, and surfaces of mere magnitudes, so does anatomy found its propositions, by assuming the existence of certain fundamental tissues or parts, distinguished by the terms fibre, lobules, and laminæ, as the elements of organized matter.

By an organized substance, we mean an object in which all its constituent parts, organs, and systems, are mutually means and ends to each other; each contributing to the support and duration of the whole; and each, therefore, being maintained by the co-existence of all the rest.

To convey a knowledge of the structure and texture of the human body, is the principal object of the science of anatomy; for as its mere name implies, and, in contradistinction to physiology, it may be said to consider the human subject as a mere organized structure; while, on the other hand, physiology recognizes man not only as an organized, but at the same time as a living being (organismus): nor does it stop here; for the science of psycology leads us still further, and treats of man as an organized, living, and intellectual being. Again, the science of anatomy of the human subject, may be distinguished into general, special, and comparative.

Descriptive anatomy, considers only the general form and denomination of the minute parts, and the variety of those organs, which, taken collectively, constitute the entire organismus, describing their general structure, texture and arrangement.

Special anatomy, on the other hand, enters not only into a minute examination of the structure and texture of all the component organs, but considers in detail, the different constituents of each part, of even one and the same organ.

The object of *comparative anatomy*, is to compare the construction of one organ in the human subject, with those of the lower animals.

The *pathological*, or morbid anatomy of the human subject, cannot be treated separately, but should rather be connected with *both* general and special anatomy.

However, since what is called the vital or living principle, its developement and modifications, as also its diseases, exercise great influence upon the structure and texture of the various systems and organs of the human body, it is obvious that some general physiological and pathological observations must necessarily be added to the lecture on anatomy.

But before I proceed in this lecture to the consideration of the general anatomy of the human body, it will be better first, to premise an explanation of the various technical terms made use of in designating the different parts of the whole body, which are as follow: tissues, systems, organs, functions, and organismus. These I shall separately describe.

First.—*Tissue*, which is intended to signify a certain arrangement in the elementary particles of any portion of an organized substance, so as to give it a peculiar texture. And hence, all those parts of an organized body in which the same arrangement is found, are said to belong to the same tissue: as, for instance, the fibrous, spongy, cellular, &c. &c.: the one being easily distinguished from the other.

Second.—A *system*, means an assemblage of parts, which, although various in their individual arrangement, are still identical in their texture, and in most systems, are each in direct continuity.

Third.—*Organs* are the assemblages of parts of the body, which, although various both in their structure and tissue, nevertheless co-operate to effect some particular purpose; as all the different parts of the liver do in the formation of the bile.

Fourth.—*Function* consists of the action of several different organs, acting in unison for the completion of one end necessary to vital existence; as digestion is effected in the conjoint operation of the stomach, bowels, liver, and pancreas.

Fifth.—*Organismus*, is a term used to express the assemblage (as before mentioned) of all the organs of the human body, performing their individual and natural functions for the perfection and preservation of the whole.

Now, in treating of any organized body, and more especially that of the human body, we must first consider its structure and texture.

With respect to its divisions, it may first be considered as divided by an imaginary vertical line, which separates it into two symmetrical sides, and, like the bodies of all other vertebrated animals, is divided into head, trunk, and extremities. The trunk forms its central part. We further observe in the whole frame, three principal cavities, which enclose the organs called *viscera*, and which are absolutely essential to life. The head forms the superior cavity, is lengthened through the vertebral column, and encloses in its whole extent, the brain and spinal marrow, the centres of the nervous system, and the senses.

The middle cavity is the thorax, and is for the purpose of containing the organs of respiration and circulation. The lower cavity, the abdomen, lodges the organs of digestion, of the urinary secretion, and of generation.

The extremities are composed of a series of bones, articulated with each other, and above with the bones of the trunk, while, inferiorly they are free; they are distinguished by the denomination of superior or thoracic, and inferior or abdominal members. All these great divisions of the body consist of many subdivisions, the detail of which belongs to descriptive anatomy; but, as a general remark, it may be observed, that both the principal divisions and the subdivisions of the whole, are determined by the extent and position of one or more of the bones constituting the skeleton.

The human body, like that of all other organized bodies, is composed of liquids and solids, which are continually changing into one another. The fluids form much the greater proportion in regard to bulk; it should however be observed, that their exact proportion to each other cannot well be ascertained, as some of the fluids are with great difficulty separated from the solids.

Some anatomists have, indeed, assumed the proportion between the liquids and solids to be as six to one; and others, even as nine to one: but their proportion varies according to the individual, sex, age, and constitution.

Having investigated and described the various parts that compose the human body, the formation of which, from their instrumentality, are denominated the organs, I shall now proceed to explain their uses and functions; thus developing that branch of the science which is termed physiology. The consideration of the structure and functions of the organs in their healthy state, will be naturally followed by that of the changes produced in them by disease or injury; and thus the department which is termed pathology, will be elucidated.

To enumerate in detail the several parts of the human body, would on the present occasion be misplaced; I shall, therefore, confine myself to such a general view of them, as may lead you to consider, how beautifully the machine is adapted to the purposes for which it is destined. The body, as has already been observed, consists of a duly proportioned aggregate of solids and fluids, subject to constant waste, which is repaired by the introsusception of certain extraneous substances, collectively termed food. Man is enabled to obtain the fresh supply requisite for his subsistence, by the aid of the senses, sight, hearing, smell, taste, and feeling; four of which are exercised by particular organs, while the nerves, ministering to that of feeling, are distributed over the entire surface of the body. As the objects of his wants may be more or less distant, it is requisite that man, in order to attain them, should possess the power of locomotion, and a form suited to the exercise of that power. A secure basis being absolutely essential to his support, the whole structure is firmly secured by a substance termed BONE; which, like a frame-work, gives support and protection to the surrounding soft parts, and maintains his proper stature. That they may not add too much to the weight of the body, the bones are formed hollow, and are thus rendered much lighter than they would be if solid, yet without suffering any diminution of their strength. The bones being the basis of locomotion, and, as such, being required to permit the most rapid and varied movements of the body, would utterly fail to answer that purpose if they formed one continuous mass; wherefore, like a complex and ingenious piece of mechanism, they are found divided into a great number of parts, so disposed as to play easily, and adapt themselves readily to every act of the body, and to every change of attitude and posture. At their extremities we find a substance, admirably adapted, by its smoothness and elasticity, to prevent concussion and friction; this substance is called *cartilage*. In those joints which are entirely subject to the influence of the will, this substance is found merely tipping the ends of the bones; but in parts where motion is considerably restricted, we find cartilages firmly uniting bone to bone: as, for instance, the ribs to the sternum. Not only are the extremities of bones protected by this substance, but friction between them is still farther prevented by a fluid termed *synovia*, which is poured from the extremities of arteries terminating on the internal surface of a synovial membrane, which prevents the escape of the fluid. This apparatus is always found at articulating surfaces; and the quantity of synovia supplied is always proportioned to the extent of motion in the joint, and to the consequent danger of displacement. Another structure forming part of every articulation is *ligament;* so called, from its function of connecting bones together. Ligaments are strong inelastic membranes, uniting the extremities of moveable bones in such a manner as not to interfere with motion, except where it has a tendency to be carried beyond its natural extent, which the ligaments restrain, and will not permit without rupture. Thus, by bones, the organs of support; by ligaments, the organs of connection; and by the substances interposed for protecting and lubricating the articulatory surfaces, the fabric of the body is rendered capable of being moved.

I shall now proceed to consider the manner in which the movements of the body are effected. The instruments or organs by which corporeal motion is performed, are the muscles.

The term *muscle*, is derived by etymologists from the Greek word *μυων*, that which contracts or closes, (from *μυω*, claudo) and aptly designates a property peculiar to this organ. Muscles are formed of long parallel fibres, connected by cellular membrane, and, in the human body, are generally of a red colour. Soft, irritable, and contractile, they are well adapted for producing the great movements that take place in the living body. On tracing a muscle, we find it originating from a considerable extent of surface, gradually converging towards a point, to be united to a chord called a *tendon.* This tendinous structure, consists of fibres of a white colour, firmly united together, and extending, in a uniform direction, to the muscle, to which the tendon is attached. By the contraction of muscles, motion is produced, as must have been experienced by all who are conscious of this faculty, though from frequent habit we are not attentive to the manner of its exercise: for instance, the *brachialis internus* is one of the muscles intended to raise the fore arm; by the contraction of this muscle, the bone into which it is inserted—that is, the coronoid process of the ulna,—is brought nearer to the *os humeri*, from which it arises; and in this way the elbow-joint is bended. The joints are provided with as many muscles as are necessary for the possible flexures of those joints in the different motions of the body, each muscle moving in a proper direction the bone to which it is attached. The extent of power in a muscle, is proportioned to its magnitude, or to the number of fasciculi composing it: hence arise the different degrees of force, or power, that are found to be exerted in leaping, running, rowing, throwing the discus, and other corporeal exercises. When you have attentively considered, how the different parts composing the fabric of the human body are capable of being separately or simultaneously moved by the appropriate organs assigned to them, and how the muscles produce the complicated and infinitely varied motions of the machine, you will be fully prepared to examine the physiology of locomotion. In walking, for instance, the first act required is, to fix one part of the body, so that the other, released from its office of contributing support, may be free to perform muscular exertion at the dictate of the will. Thus, while one leg sustains the whole weight of the body, the muscles of the other are brought into action; the limb is raised and extended; the body is brought forward by the muscles of the fixed side, and its weight is transferred to the advanced limb, which in its turn becomes fixed, and sets the other at liberty to advance.

In adverting to locomotion, I have already supposed that the great purposes of this faculty, are to enable the animal to approach those objects which may serve as aliment, and to shun those from which it may apprehend danger, molestation, or annoyance. Here we perceive a great distinction between the two great classes of organized bodies,—the animal being capable of changing its situation, while the vegetable is necessitated to remain stationary. By the locomotive faculty, man is enabled to procure all the substances capable of being converted into nutriment by the action of the digestive organs. Of such substances, there is an almost infinite variety; man being, in the phraseology of the naturalist, an *omniverous* feeder. The food is conveyed by the hand to the mouth, which is opened for its reception; it is then masticated by the co-operation of the upper and lower jaw, formed into a rounded mass by the tongue, lubricated by a fluid of the mouth, and thus rendered fit to be swallowed, as well as to undergo certain changes in the stomach. The food thus masticated and prepared, is passed by the action of the tongue upon the soft palate, into the cavity of the fauces, towards the pharynx. Stimulated by the presence of food, the pharynx contracts and presses it into the canal of the œsophagus, the muscular fibres of which by their action convey it into the stomach.

From the organs necessary to the processes of deglutition, I pass to the digestive organs, commencing with the stomach; a membranous bag, which is situated in the cavity of the abdomen, and which constitutes another important distinction between the animal and the vegetable kingdom; animals receiving their nutriment into an interior organ for assimilation, while plants imbibe theirs at the surface. The stomach is found in every animal, and may be considered as constituting the organic difference between the animal and the vegetable world. The process by which food is converted into nourishment, and which constitutes the peculiar office of this organ, is termed digestion. By the action of a powerful solvent called the gastric juice, supplied from the glands of the stomach, the food is converted into a pulpy substance called *chyme*, and it then passes through the pylorus into the duodenum, where it mixes with other fluids, the bile, the pancreatic and the enteric juices, and is converted from chyme into *chyle*. The whole of the substance however is not transmuted into chyle, for a considerable portion of it passes away as useless and feculent matter. That portion of it which is proper for corporeal sustenance, is taken up by the absorbent vessels from the small intestines, which are furnished with a number of folds of a valvular structure, called *valvulæ conniventes*, which tend to retard the passage of the feculent matter, and by enlarging the surface enable the lacteals to take up such portion as may still prove nutritious.

This rather minute detail of the alimentary process, appeared to me requisite, for the purpose of shewing how the continual waste, or wear and tear of the body, is supplied and repaired by the assimilation of the various substances collectively termed food. We are now to trace the nutritive part of this aliment from the stomach and intestines, into the vital system, or, as it is commonly called, the circulation. The nutriment having been taken by the lacteals from the intestines, passes through a membrane called the *mesentery;* and in this state, if examined shortly after an animal has taken food, it is found to consist of a white opaque fluid resembling milk. It passes from the mesentery to a large canal, called the *thoracic duct*; which, originating from the loins, extends along the spinal column, and through the chest, terminating at the junction of the internal jugular, with the subclavian vein. The direction of the fluid in its passage to the thoracic duct is uniform, there being a certain valvular apparatus, which presents an insuperable resistance to any retrograde movement. It is thus conveyed into the blood to be circulated with it, and to contribute to the support, accretion, and reproduction of every part of the body. We find, therefore, that the constituent parts of animal bodies, though so different in many particulars, are all formed from one common element, into which they are capable of being resolved; nor can this homogeneity excite surprise, when we consider that it is from the blood that every structure in the body, from the firmest to the most fluid, must derive its supplies.

The blood itself, however, is composed of several distinct constituents, as may be demonstrated from the separation which takes place in any portion which has been drawn from the living body.

To the circulation of the blood, we cannot advert without being reminded of the great and immortal name of Harvey, who, in 1628, first comprehended and demonstrated that important function which had baffled the philosophic inquiries of his predecessors, ancient and modern; constantly stimulated as they must have been, by a phenomenon so remarkable as that of the pulse. It is by circulation that the blood conveys the means of nutrition to every part of the system, being propelled from the heart, and reconducted to that organ. The heart is a hollow muscle, situated within the chest, composed of two cavities separated by a partition. These cavities are each divided into an auricle and a ventricle, which communicate with one another; thus the heart is divided into a right and left side, the former receiving the venous, and the latter the arterial blood. I know not that I can better explain the nature of this apparatus, than by describing the circulation. In the first place, then, two large veins called the *venæ cavæ,* convey dark-coloured blood to the right auricle; a portion of this cavity being muscular, is capable of being stimulated by the presence of blood; hence it contracts and propels its contents into the right ventricle, which in its turn contracts. The fluid, prevented by a valve from returning into the right auricle, passes into the pulmonary artery, and is conveyed into the lungs, a spongy, parenchymatous organ, occupying a considerable part of the thorax, and admitting ramifications of the wind-pipe, so as to be freely permeated by atmospheric air, which is renewed by respiration. So minute is the distribution of the pulmonary artery, that every particle of the blood is brought within the influence of the air that is inhaled; by this exposure it undergoes a chemical change, which, among other results, produces that of changing the colour of the fluid from black to red. It is then received by the four pulmonary veins, as blood adapted for the supply of the body, and is conveyed to the left auricle, from whence it passes to the left ventricle, at which terminates the proper circulation through the heart and lungs. At this stage of its progress, a fresh mechanism is required for conveying the blood to every part of the frame. This purpose is accomplished by a series of elastic tubes, constituting the arterial system; through these arteries the blood receives its first impulse from the contraction of the heart, which is called the *vis à tergo,* and which is maintained by the elasticity of the external arterial coat. By some physiologists, however, the flow of the blood through arteries, is supposed to depend on a muscular power resident in those vessels. As they extend toward their terminations, the trunks of arteries diverge into innumerable ramifications, and expend themselves by inosculating with veins. These may be considered as constituting the second division of blood-vessels, and they are sufficiently distinguished by a difference of colour in the fluid which they circulate. The change of colour is attributable not to the abstraction of any thing from the blood, but to the absorption of new matter into it during its course from the heart, this alteration being effected by chemical agency.

The *veins* take their origin, in minute branches, from the capillary extremities of arteries; and, by their progressive union, ultimately form the two great veins already designated as the *venæ cavæ*, which empty themselves into the right auricle of the heart. In the interior of the veins, we find a valvular structure, adapted for preventing the regurgitation or retrocession of the blood.

In this general view of the circulation, we discriminate the respective functions of the three kinds of blood-vessels. The *veins* convey the chyle and blood towards the heart; the *artery* carries the blood from it; and the *ventricle* gives the necessary impulse, on one side to the lungs, and on the other to the arterial system,—thence to be distributed throughout the body.

The necessity of the pulmonary circulation, and of the exhalation of something that is incapable of sustaining the vital functions, is abundantly manifest, from the fact that exhaled air is not adapted to sustain life. The purpose of the auricles appears to be that of serving as a receptacle for the venous blood, while the ventricles are acting upon that in the arteries; for they are rendered sufficiently distinct from one another by means of valves, during the action of the ventricle, to be prevented from acting upon the auricle during their contractions. Hence it is clear, that the two auricles, and the, two ventricles must operate in unison,—their action must be synchronous. By the propulsive force of the ventricles, such an impetus is given to the blood as to produce distention and momentary vibration in the arteries—a phenomenon which is commonly and aptly termed pulsation; but in the veins, the blood flows in an even and equable current—the momentum, originating in the heart, being expended before it reaches them.

Thus, the circulation may be regarded as including two consentaneous and co-operative systems,—the venous and the arterial; the one serving to build and repair the body, while the other supplies the materials. It may be proper to inquire into the means by which the various and very different parts which constitute the human frame, are all produced from one homogeneous fluid. This wonderful result will be traced to the extremities of the arteries, where it is effected by what are called the functions of exhalation and secretion. The fluids are produced by exhalation, where arteries terminate upon any surface, under an arrangement so peculiar, as to allow the separation of certain of the constituent parts, without the intervention of any organ, the separation taking place from the vessels themselves. On the other hand, the secreted fluids are produced by a mechanism much more complicated, and which effects in them an infinitely greater difference from the blood itself. For instance, if we examine the bile or the saliva, we discover in either of those fluids very different properties from those possessed by the blood; while the fluids produced by exhalation, bear a strong resemblance to that which blood would become, if deprived of its red particles. To elaborate the change in one case, a substance called a gland is provided, into which arteries ramify, and in which originate a new set of vessels, termed excretory ducts, for the conveyance of the fluid to some organ in subservience to a peculiar function; in the other case, the exhaled fluid is usually returned into the circulation by the process of absorption. Thus it would appear, there is a great difference between the two processes; that the one is very simple, and the other extremely complicated. Hence the abundant supplies furnished to every part of the body, are derived from the ramifications of the arteries through two distinct processes.

We find that exhalent vessels are constantly pouring out fluids; as, for instance, those within the cavity of the peritoneum, and those which supply synovia for lubricating the joints. This latter fluid would be constantly accumulating within the cavity of the articulations, were it not for another operation which is in constant progress; its tendency being to maintain an exact proportion between the fluid secreted, and the fluid removed, and thus to prevent distension in the secreting cavities of the body. If we inquire into the origin of this the *absorbent* system, and into the purposes for which it is adapted, we shall find that the absorbents, while they act as the constructors of the body, reject what is superfluous, or would be injurious, and take up that only which is proper for its nutriment or advantage. Like the arteries, these vessels are found diverging into ramifications, arising from all the mucous and serous membranes, and also from the cellular membrane. They anastomose also like arteries, and form large trunks, which do not pass at once into the thoracic duct, but subdivide and enter into an adjacent apparatus, called absorbent glands. The vessels into which they thus subdivide, are called *vasa inferentia;* and those which pass out from the same gland, are denominated *vasa efferentia;* the former have the superiority in number, the latter in capacity. On examining the structure of these vessels, we find their *parietes* thin and diaphanous, composed of two coats; the inner coat forming folds, which are termed *valves*, and which resist any retrograde motion to a degree exceeding the apparent firmness of their substance. They have the power of taking up the fluids that come in contact with their orifices, and of conveying them into the circulating blood; this function, termed absorption or inhalation, must exist wherever such vessels occur. It is also to be remarked, that the absorbents are adapted for the removal of the solids, which, however, must have previously undergone solution.

It is an ordinance of nature, that animals should have the power of propagating their own species; and they are accordingly provided with generative organs, in the respective formation of which consists the distinction of the sexes. Those organs, in either sex, are divided into external and internal: the external may be considered as destined for the purpose of procreation; the internal, in the male subject, include the apparatus requisite for producing impregnation, while those of the female are adapted for conception and gestation.

Our attention must now be directed to the cellular membrane,—a soft, spongy tissue, extending through all the divisions of the body, surrounding all the organs, forming at once their medium of union and separation, penetrating into their substance, to pervade in like manner their component parts; thus entering into the organic structure of all organized bodies, and constituting the principal element of organization. This substance may be regarded as consisting of true cellular membrane, and of adipose membrane; the former being universally diffused, while the latter, is excluded from the eyelids, the scrotum, and every other part where the presence of fat would interrupt or impede an essential function. The whole exterior surface of the body we find to be covered with a strong elastic integument, called the skin: it is divided into two layers, of which the internal is called the true skin, and the external is termed the scarf skin, or epidermis. Anatomists have distinguished a third layer, which, from the characteristic colour, is quite apparent in negroes; and this they denominate the *rete mucosum.* It is the property of the skin, not only to afford protection to the organs beneath it, but to exercise functions peculiar to itself; namely, the exhalation of a gas, the exudation of perspirable matter, and of sebaceous secretions, and at the same time permitting the excrescence of the hair.

In this general view of the human frame, you may have observed, that its component parts, which have hitherto engaged our notice, are divisible into two classes—the *mechanical* and the *vital* organs. Of the former class, the bones may be considered the organs of support; the ligaments those of connexion; and the muscles those of motion; while the organs of the latter class; respectively perform the functions of assimilation, circulation, exhalation, and secretion.

In proceeding to consider the intellectual organs, which may be regarded as forming a third class, we are to observe, that the wonderful structure which we have been contemplating would remain inert and passive, were there not a medium of communication between the faculties, comprehensively termed MIND, and the organs subjected to that act of the mind, denominated VOLITION, or WILL. That this mental sovereignty may be exercised,—that the presiding intellect may be informed,—and that its decrees may be executed by the subordinate agencies, man is furnished with a nervous system, consisting of brain, spinal marrow, and nerves, which, being acted upon by various sensations, produce impressions on the mind in its supposed residence or sensorium, the brain. I say its *supposed* residence, because, in tracing the connexion of matter with mind, we loose the clue of demonstration, and have only strong inference or conjecture for our guide; that connexion, like vitality itself, is a mystery which human reason cannot unveil. The brain is situated in the head, in direct proximity, be it remembered, with the "local habitation" of four of the five senses: the spinal marrow is placed in the vertebral column, and the nerves are distributed through every part of the body. These three grand divisions of the nervous system are more or less connected with each other, and are reciprocally subservient. The impressions of which the brain is susceptible have been distributed into five classes, corresponding with the five senses: but it will be more correct to say, that each of these senses communicates its peculiar class of impressions. The sense of touch, for instance, conveys to us the notions of roughness, smoothness, hardness, softness, and many other qualities; and the same observation may apply, in a greater or less degree, to the rest of the senses. Without going into detail respecting them, we may observe, that these sensations are conveyed through the respective nerves to the sensorium, the brain. But this organ is endowed with other faculties, which cannot now require to be enumerated: our present purpose is to particularize *volition*, by which it operates instantaneously, through the different nerves, on such parts or organs of the body as are subject to the influence or control of this faculty. We may add that it operates simultaneously on parts which are distinct and remote from each other. The grand distinction between sensation and volition appears to be this:—sensation commences at the extremity of the nerves, and passes to the brain; while volition originates in the brain, and passes through the nerves to the limbs and other parts of the body that are susceptible of voluntary action, and are naturally actuated according to the purpose which the mind has willed to achieve. I would not here be understood to trench on the province of the moral philosopher, but to consider these phenomena in a strictly physiological point of view; I speak, therefore, of volition as a faculty participated by other animals in common with man. The sensation of hunger urges the lion to prowl for prey: the same sensation impels the savage of the woods, the mere animal man, to dig the earth for roots, or to slay the beasts of the field. The difference between man and the noblest of the inferior tribes of animals, consists, as I have already observed, in that reason, which, ever progressive, developes new resources for supplying his wants; and, as civilization advances, brings into clearer light those immutable principles of equity, which, tempered by the social virtues, constitute that bond of union among all families, communities, and nations of the earth, universally recognized, in its most extended and exalted sense, by the honourable name of *humanity.*

Having noticed the two great qualifications of sensation, and of will, as peculiar to the nervous system in general, I may now observe, that the nerves are subjected to another kind of action, which in no degree obeys the control of the will, and which influences the involuntary functions of life. This influence operates through the agency of the sympathetic nerve; so called, because it supplies, in common, those organs of which the constant action is essential to existence. This nerve is connected with the brain, as well as with the spinal marrow; and from their union may be solved the problem, why mental impressions are capable of affecting the involuntary and merely mechanical action of certain organs. Thus we may account for the acceleration in the beating of the heart, and in the peristaltic motions of the intestines, when the mind is actuated by fear, or any other strong emotion. Not only does the brain serve as the principal abode of those qualities which are capable of sustaining the indispensable functions of organic life, but it is the council-hall—the consistory, in which the intellectual functions are exercised, and all mental operations performed. In the brain reside intellectual conception, the offspring of sensorial impression: memory, including the power not only of remembering, but of recollecting at will, events or facts which have once been known: imagination, or the power of forming new combination: and judgment, or the faculty of comparing or distinguishing right from wrong, truth from falsehood, equity from injustice: all these faculties, when cultivated and improved by proper exercise, serve to qualify and accomplish man as a social being; and to elevate him to that station, which his Creator intended him to attain, as the sovereign lord of that earth, which he was authorized to replenish and to subdue.

In concluding this outline of the course of study upon which you are about to enter, I would intreat your farther attention, Gentlemen, to some observations on the subject of those duties which you owe to yourselves, to your parents, and, I may add, to the community at large; for upon the faithful and zealous fulfilment of them, depends the question whether you are to be the most useful or the most dangerous members of society. I feel, therefore, as surgeon of this hospital, and your teacher of anatomy, that I ought, in terms of no ordinary earnestness, to impress on your minds the necessity of a diligent and judicious application of your time during your stay at this school. The interest I take in your welfare, the anxiety I feel for your advancement to eminence, the satisfaction I shall ever derive from the reflection of having contributed to it, and the hope (not, I trust, a misplaced or visionary hope) which I cherish that my wishes will be realized, call loudly on me to entreat your assistance in the undertaking. It were a superfluous office to remind you, that it is not on me, but on yourselves principally, that your future success depends. The science of anatomy is easily attained, when the determination to attain it is sincere; in this pursuit, no difficulties will arise which attentive assiduity may not surmount; and no barrier will be opposed to your ultimate success, which idleness has not erected. Among the votaries of this science, as of others, there are many who profess to disclose a shorter path to excellence than that of industry; in this, as in other studies, many expedients have been devised by which the toil of research and deduction may be saved; but let no man be lulled into indolence by specious promises:—excellence is never granted to man, but as the reward of labour. It evinces, indeed, no small strength of mind, to persevere in habits of industry, uncheered by the animating pleasure of perceiving the advancement made; which, like the hand of the clock, unerringly accomplishes its circles of the hour, yet so gradually as to escape observation. Remember, that anatomy is the basis of surgery; and that if the basis be not solid, the superstructure cannot be secure: there scarcely exists a case in surgery in which the knowledge of anatomy is not required; and I have little hesitation in asserting, that when professional disgrace has fallen upon any members of our profession, is is very rarely that the causes of that disgrace, may not have been ascribable to ignorance of this essential department; as essential, indeed, as mathematical science to the navigator. Should you, as most of you probably may in the course of your practice, be summoned to give evidence in a court of justice, when the learned judges on the bench look to you for the illustration of the case before them; and the life or death of the accused, rests solely on the evidence which you may present,—consider what an awful responsibility is vested in you. The counsel retained, take care to supply themselves with all the anatomical knowledge which the case may require, and your professional reputation may be materially affected by your replies.

Medical men are perhaps more liable to be depreciated in public estimation by forensic evidence, than by any other contingency. Questions are put by counsel, which require a most minute knowledge of anatomy and pathology, to answer satisfactorily; and the hesitation which must inevitably accompany an imperfect knowledge of those sciences, must produce a most unfavourable impression on all present; an impression detrimental to the future prospects of the witness. Agitation, embarrassment, constitutional timidity, can scarcely be alleged in extenuation of a member of a profession, in which presence of mind is an essential requsite; and when even the diffidence that so often attends real talents and acquirements, will be but too often illiberally misrepresented.

That the path to eminence is rugged, and the ascent steep, I freely admit; if such difficulties did not intervene, there would be little merit in attaining the summit; yet the way is open; the path, though rugged, is clearly to be traced; and as to what may depend on confidence in the guide who is to conduct you, I pledge myself that you shall not be deceived. Though I stand here as your instructor, it were my prouder boast to be regarded as your fellow-labourer. I would wish you to look on me only as one who has toiled through the journey, and is about to recommence it with you, only that he may facilitate your progress. Whenever, therefore, you may do me the honour, Gentlemen, of soliciting my assistance, rest assured that I will afford it to the utmost of my ability; and if I can contribute by any exertion of mine to your instruction and advancement, I shall feel a happiness commensurate with the benefit which you may derive. I hope that I am addressing those who are as anxious and as determined to become useful members of society, as I am to assist them, by all the means in my power, for the attainment of that laudable end. You have selected and embarked in a noble, an honourble, and a useful profession; and you feel determined, I doubt not, to uphold its respectability. Remember, that you are about to be surrounded by a multitude of temptations; of which you must bear to be told, that they are dangerous in proportion to the difficulty of resisting them; and which it will require no ordinary share of fortitude, combined with a manly and salutary sense of their danger, victoriously to withstand. There are among you those who, gifted with talents and education, enjoy also the advantages of property, of address, of personal appearance; these qualities, however, if they be not converted into ministers of your welfare, your best friends, will prove your greatest enemies. If the money which your relations have devoted to the purpose of your education, or generously bestowed on you for your personal comfort, be dissipated in folly or lavished in extravagance, while your time is consumed in idleness, you will return home, tortured with that remorse of conscience which is the bitter and inevitable consequence of such conduct; and, instead of being received with affection, you will be met with frowns—the just token of displeasure from those to whom you were dear—whose liberality has been abused, and whose hopes have been defeated. There may be some among you who have to depend solely on their own industry; who look alone to their own exertions for subsistence, and who must ultimately beg or starve, if they neglect their duty: "that merit rarely attains to eminence, when restrained by want," is a lamentable truth; but it may be no small consolation for those who may have to struggle with adversity, to be reminded, that some of those whom our profession is proud to acknowledge as her brightest ornaments, have worked their way from poverty to affluence—from obscurity to imperishable renown. It is not your daily attendance on lectures, or your regular appearance in the dissecting-room, in compliance with the customary routine of study, that will at all avail, unless your attention be exclusively devoted to the subject before you. In this, perhaps, more than in any other pursuit, the Roman maxim should be emphatically enforced: "that which deserves to be done at all, should be done in the best possible manner;" or, in briefer phrase, whatever you do, let it be done effectually; done with heart and soul. Let not your time be absorbed, and your attention altogether distracted, by taking notes of these lectures; as that which is mechanically and literally committed to paper, is too often lost to the memory. When you go home from lecture, deliberately and carefully recall to mind that which you have heard; it is the notes taken subsequently that will most redound to your advantage; what is then written will be easily recollected, while dissection will rivet it in your memory, and accomplish you as anatomists.

A few words, Gentlemen, on your conduct when you shall have embarked in the practice of your profession, and I will trespass on your time and patience no longer. Be not misled by the delusive notion that in acquiring a proficiency as anatomists, and even in qualifying yourselves to become eminent as surgeons, you will have ensured professional advancement; the general line of conduct, the kindness and attention to patients, the pains taken, in short, to render yourselves worthy to be beloved as men, while you are esteemed and respected as surgeons, will materially influence your success. You will have to prepare for numerous difficulties, many of them unforeseen and to be promptly encountered; but he who cannot strain against, and stem the adverse tide, should not launch forth into the troubled sea of life. Remember, that in proportion as you become objects of envy to your competitors, you will become objects of detraction. When you have to confer with scientific men, treat them with the respect they merit; when you meet with ignorant practitioners, bear with them. Do your duty to your patient, but never for a moment imagine, that the ruin of another's professional character can advance you a single step in the path to eminence.

That calm presence of mind which directs the hand, will be found most favourable to the exercise of the judgment, in your general conduct; and as I entertain no doubt that you are determined to be good surgeons, so I am confident that you will ever cultivate those gentlemanly feelings which should characterize and adorn your destined rank in society.

These suggestions, Gentlemen, you will consider, not as authoritative precepts, but as appeals to your good sense; and accept them, with my best thanks, for your attention. I need not again remind you of the value of that time, even in its minutest portions, which is devoted to scientific pursuits; satisfied that your youthful and ingenuous ardour will inspire you with that unity of purpose, which is the best earnest of success, the surest prognostic of an honourable and splendid career.

LECTURES ON ANATOMY.

PART I.

THE OSSEOUS SYSTEM.

LECTURE I.

PHYSIOLOGY OF THE BONES.

The fabric of bone consists of a fibrous tissue, resembling in its general characteristics, the fibrous texture of other parts of the body; but possessing some peculiar qualities, forming them into a distinct system, and which is readily distinguished from other systems, by its hardness, whiteness, and opacity.

In pursuing the investigation of this system, we shall have to treat of its physical, vital, and chemical properties; and to point out, that, notwithstanding the hardness, and earthy compounds of its structure, it still, as evinced by its growth, and diseases, is equally endowed with the principle of vitality, pervading the whole economy.

The osseous system consists of those hardest parts of the human body, which, when arranged in their proper order, and connected by their natural ligaments, are well calculated to support the soft parts attached to them; and, indeed, to constitute a framework by which the machine may be managed when in active motion, and sustained when quiescent.

All the bones, excepting the teeth, are more or less deeply seated; each being surrounded by soft parts, and presenting no exterior surface. They are covered by the muscles and integuments, which adapt them for the support of the arterial and nervous systems, and for the formation of joints.

The number of bones is considerable; amounting, at the adult period of life, to two hundred and forty-one; but they vary according to age. Many of the bones which are single when ossification is completed, during infancy are separable into many parts. This provision has a two-fold advantage, rendering, in the first place, parturition easy, and secondly, affording a support increasing in the ratio of the increment of the body.

The size of the different bones varies considerably: some of them are found to measure nearly a fourth of the whole length of the body, while others are but a small portion of an inch in extent; and from this difference in their size, some anatomists have classed them.

Bones are also divided into portions, as regards their individual extent: thus the bones that exist singly, are said to consist of a body or centre, and of two sides, joined by an imaginary middle line, which divides them into symmetrical halves. Again, some bones are distinguished into parts, according to the uses which those parts serve: thus the os frontis is divided into the orbital and nasal processes.

The different mechanical purposes for which bones are employed in the animal economy, require them to be of various forms.

With regard to the geometrical figure of bones, they are divided into three classes. The *long bones*, are those in which the dimensions of length considerably exceed those of breadth and thickness: others, in which the length and breadth are nearly in equal proportions, are termed the *flat or broad bones:* whilst those whose length, breadth, and thickness are nearly equal, are distinguished as the *short bones*. There is, however, a fourth class, in which no one of these dimensions sufficiently prevails to entitle them to any class in the above arrangement,—these are the *mixed bones*.

Bones of the first class, are situated in parts of the body where extensive motion is required—the limbs are composed of such bones. The second class, or the flat bones, have nearly all of them concave or convex surfaces, destined to protect important organs, for which their curved form admirably adapts them, by giving them a power to resist external violence. The third class, is found in parts of the body where rapidity of motion is required, combined with great strength: such bones, therefore, are found composing the carpus, tarsus, and spine.

The single bones of the skeleton, are symmetrical in their form, have their sides uniform, and are found in the mezian line of the body; while those bones that exist in pairs are invariably alike. The short bones have no great uniformity in their external configuration, as they are modified according to the general purpose of that assemblage of bones, of which they individually form a part: thus we find the different uses of the carpus, metacarpus, and spine, determine also the variety in the external form of the small bones that compose them.

All the bones present on their external surface irregularities, which may be termed *eminences*, and these again are denominated either epiphyses or apophyses: the former are bony parts of a secondary completion, and will therefore be more particularly described when speaking of the developement of bones: while the latter, or apophyses, are processes of the original bone. These apophyses offer considerable varieties, both as to their use and configuration. They may, however, be divided into three grand divisions:—First, apophyses of *articulation*; secondly, of *insertion;* and thirdly, of *reflexion*.

Those of the *first* division, or the apophyses of articulation, differ according to the figure and motions of the joint of which they are destined to form a part, and will be more particularly described when speaking of the joints in general.

The *second* division, the apophyses of insertion, are very numerous in most of the bones: they are for the purpose of giving attachment to muscles through the medium of their tendons; they also afford attachment to ligaments and aponeuroses. These apophyses are much less developed in the female, than in the male; in the weak, than in the robust. Moreover, whether the apophyses be projecting portions of bone to receive a tendinous attachment of muscle, whether it be in the form of an extended *line* for the aponeurotic attachment, or whether it be the *asperity* for the direct attachment of muscular fibre, we uniformly find the developement of each of these kinds of apophyses proportionate to the energy of their respective muscles. The varieties in the external configuration of the long bones, produced by the degree of developement of these apophyses, are often very considerable, but without any corresponding deviation from the regular cylindrical form of their interior. The apophyses for ligamentous attachment, are intended to remove, in some measure, the ligaments from the surface of those bones of which they are the uniting substance in the formation of a joint.

Those of the *third* division, the apophyses of reflexion, are such, as under which a tendon passes in deviating from its primitive course: they are generally excavated; and, by the assistance of a ligament, formed into complete rings for the passage of tendons.

Bones have likewise depressions or cavities, which are distinguished into *articular* and *non-articular:* the latter are found to be either confined to the external surface of the bone only, or to extend deeply into its substance. In the former of these instances, the bone is particularly adapted for the attachment of muscle, as by such depressions it presents a larger surface; whilst in the latter case, they serve for the formation of cavities. Of the non-articular depressions it is now my purpose to treat, leaving the articular depressions, with their corresponding eminences, to be described when speaking of articulations.

The *non-articular* depressions are divided into those on the exterior, and those within the bones. Those on the surface of the bone, are divided into three kinds:—First, those of *insertion;* secondly, of *reception;* and thirdly, of *facilitating motion.* Those of the first kind, give attachment either to the aponeurotic insertion or origin of muscles; and from their concavity, offer the advantage of enlarging the surface of the bone, and thereby of multiplying the points of attachment of the muscle without increasing the bone itself. The pterygoid and digastric fossæ are examples of this class.

Secondly, the cavities of *reception*, are those which serve to lodge and protect an organ; these are principally found upon the flat bones, as on the bones of the skull and pelvis. These cavities sometimes form the whole of one surface of the bone, and at others are insulated depressions. The venter of the ilium is an example of the first, while the depression on the outer side of the orbit, for the lachrymal gland, illustrates the latter variety.

Thirdly, the cavities for facilitating motion, are generally found at the extremities of the long bones: they are fissures, more or less deep, in which the tendons glide to pass to their insertions. They are lined with cartilage, and formed into complete foramina by ligaments, which tie down the tendons in their passage through the grooves.

There are also enclosed cavities in bones, which produce in the long bones cylindrical canals, forming the medullary cavities, occupying the middle of the bone, and terminating at its extremities in the areola of the spongy substance. These canals tend to render the bone lighter in proportion to its bulk, and stronger in proportion to its weight. In infancy, while the extremities of the bones are cartilaginous, the medullary canal is shorter in proportion than in the adult; and, indeed, is not completed until the epiphyses are perfectly ossified. Even in the first formation of callosity, after the fracture of a bone, this canal is obliterated by being filled up with cartilage, and is not re-established until this cartilage is completely converted into bone. There are no bones in the human body that have their medullary canal extending through their whole length. There are also canals found running into bones for the transmission of blood-vessels, as well to the medullary system, as to the bones themselves, which are termed the nutritious canals: their direction varies in different bones, and will be noticed when describing the anatomy of each particular bone.

Another kind of cavity found within the interior of the bones, more especially belongs to the bones of the head, and forms what are called the *sinuses*. The sphenoid, ethmoid, and frontal bones, each form such cavities, apparently produced merely by the separation of the outer from the inner table of the bone; small bony bands proceeding from the one table to the other, so as to produce a cellular appearance. These sinuses are for the purpose of producing modifications of the voice. Precisely the same organization may be observed in the medullary canals of the long bones.

Structure and Texture of Bones.

The structure of bones, like that of most other parts of the human body, is fibrous: the fibres are either so arranged as to form laminæ, more or less compact, or so interwoven as to constitute a cellular or reticulated tissue. The fibres, then, which may be considered as the basis of the bony structure, differ from the fibrous structure of every other part of the body, only, in containing a portion of earthy matter. But this fibrous and earthy matter, which are observable in every bone, are not to be considered as constituting two different tissues, but rather as two constituents of one and the same tissue.

The cellular tissue of bone, is not at first apparent, but it is formed when the calcareous phosphate is added, upon the gelatine of the cartilage being absorbed; and the cells are not completed until the epiphyses have disappeared. All the cells of a bone communicate, so that each bone may be considered as forming a general cavity, intersected by innumerable fibres.

The density of the osseous system, its great characteristic, is not found to be the same in all bones, nor even in the different parts of one and the same bone. It is with regard to the various densities of their tissue, that the different parts of bones are distinguished into the *compact* or *cortical*, *spongy* or *areolated*, and *cancellated*. These three textures are well exemplified in the long bones, which are compact in their bodies, spongy at their extremities, and cancellated in their interior. In the *compact* tissue, the fibres are not arranged as in the cellular, leaving so little interspace, that by their proximity its characteristic density is given to it. But the arrangement of the fibres of the compact tissue, is not similar in all bones, nor even in every part of the same bone. There are, in fact, three dispositions of the fibres; in the long bones, they generally run in parallel lines; in the flat bones, they radiate; and in the short, they intersect each other. These arrangements may be demonstrated, by exposing bone to the influence of dilute nitric acid. The disposition of the compact, and spongy tissues, with respect to their relative positions, also varies in the different classes of bones; but in general, the compact texture forms the exterior of the bones, whilst the cancelli occupy the interior. In the long bones, their centre is found the most compact; which not only renders them stronger at this point, where strength is particularly required, but also tends to maintain the symmetry of the limb, by permitting the bone to be smaller in consequence of its increased density.

In the flat bones, the compact texture forms an outer and inner table, with the cellular tissue between them, which is thicker in the circumference than in the centre, where the compact tables are frequently in contact.

In the short bones, the cellular tissue preponderates, although they also are furnished with thin outer compact laminæ.

Notwithstanding the hardness and solidity of bones, they nevertheless possess a degree of elasticity, which may be considered as answering an important purpose in the animal economy; for this elasticity tends to prevent fracture, and injurious pressure upon important viscera, from external injury: and further, enables a bone to resume its natural situation when displaced by the pressure of a tumour, as is seen in cases of polypus nasi.

Growth and Production of Bone.

Although the frequent attempts of the ablest physiologists have failed to explain the ultimate cause of ossification, and although nothing beyond mere hypothesis has hitherto been advanced on the subject, yet are we able to observe and describe the changes which succeed each other, before the bones appear in the human subject in their perfect hardness.

Those parts of the fœtus destined to constitute the osseous system, are found to undergo three distinct changes: from being originally in a fluid state, they pass into a gelatinous consistency, secondly into a cartilaginous form, and thirdly, into a bony substance.

The process of ossification then commences, proceeds, and is completed in the following order:—The first deposition of ossific matter is observed to take place in the substance of the original cartilage, but not on its surface; that portion of the cartilage immediately in contact with the osseous points becomes vascular, and, consequently, of a red colour. The osseous points, thus formed, gradually extend themselves from the centre to without,—the cartilage diminishing in a corresponding ratio, until at length it entirely disappears. The cartilage, then, is found to be absorbed as the bony structure is deposited: hence, ossification cannot, in strict propriety, be said to be effected by a deposition of an earthy matter into the previously formed cartilage, but, on the contrary, that the ossific process consists of an entirely new formation—a formation of a structure composed of an animal and earthy matter.

Shortly after conception, the whole of the bony system forms a transparent mucous mass, which is not converted into the cartilaginous state until two months of uterine gestation; at least, not in such bones as are late in their formation: some, however, which are essential to existence, immediately after birth pass through the changes alluded to at a much earlier period, and with singular rapidity:—of this kind are the ribs and vertebræ. The ossification of the long bones also takes place very early in the fœtus; for, at the beginning of the third month, the bony cylinders are nearly completed: their extremities, however, continue in a cartilaginous state till a much later period. The flat bones of the cranium begin to ossify about seventy days after conception, at which period the dura mater is found highly vascular.

With respect to the progress of ossification, as it proceeds in different bones, it is found in some to take place from the centre, and from thence gradually to extend to the extremities or sides; while in others, it commences and proceeds from several points at once. In the long bones, again, a different order is observed: in these, ossification takes place in the body from several points at once, and proceeds from these points as from so many centres. The extremities, however, of these long bones, which until the age of eighteen are called the epiphyses, are not perfected till that period, when the whole bone becomes completely ossified. The mode by which these epiphyses are ultimately connected, with the body of the long bones by ossific deposit, is precisely the same,—various centres of ossific matter uniting with each other, as in the rest of the bone: but the process is much slower, and, as has been observed, is not completed until the age of eighteen, at which period we suppose a harder substance than cartilage is necessary to support the weight of the body, and meet the increase of muscular action.

The epiphyses of the lower, are ossified earlier than those of the upper extremities. The projecting apophyses of bones also undergo a process similar to that which takes place between the epiphyses and the long bones,—all such processes being originally united to the bodies of the bones by an intervening cartilage, as may be seen in the growth and developement of the trochanter major. The cancellated structure of bone is not completed until the epiphyses have disappeared.

With respect to the growth or increase of different bones, this proceeds, in long bones, not only by the successive deposition of new bony matter around that which has been already formed, but also by the lengthening of the bone at its extremities. The increase of the flat bones takes place much in the same manner, by a successive addition of osseous substance at the edges of the bone, as is seen in the bones of the cranium; and by the convertion into bone of the epiphyses which cover their margins, as may be observed in the scapula and bones of the pelvis.

Although the bones grow in breadth, as well as in length, they are found to increase more rapidly at their extremities than at their circumference. It is further found, that bones attain their perfect formation in the same order as they followed in their growth; and that, therefore, those parts of a bone which first began to ossify are the first to be completed. The cylindrical bones, with a few exceptions, form and perfect themselves sooner than the flat bones,—and these, again, sooner than the short bones. It is, moreover, a remarkable fact, that the bones which began to ossify first, are also those that are soonest repaired after injury.

After the bones have ceased to grow, which is not till after the epiphyses have disappeared, they undergo certain changes, the most remarkable of which is their decrease. This decrease is effected by an absorption of the interior of the bone; and hence it is that the medullary canal of the long bones, and the internal cancellated structure of the flat and short bones, are constantly increasing; and hence, also, the reason why the skeleton of an aged is much lighter than that of a young subject.

The articular surfaces of the bones of the inferior members, and of the vertebræ, become, in old age, enlarged and flattened, as if, from the continued pressure of the weight of the body, they had at last yielded. The same cause produces a similar effect upon the neck of the femur, which, in advanced life, is always found so depressed as to form a right angle with the shaft of the bone, whilst, at an earlier period, it rises and projects at an angle of 40°.

Tissues entering into the Composition of Bone.

The following tissues belong essentially to the organization of bone:—The *periosteum, medullary membrane, blood-vessels, nerves, and absorbents.* The membranous covering which is common to the whole osseous system, is generally, but not in all situations, termed periosteum, for on the bones of the skull it receives the name of *pericranium*. The natural colour of this membrane, whether under the name of periosteum or pericranium, is white, and the texture fibrous; the numerous small vessels which ramify upon it, are afterwards distributed to the bone itself. Nerves, as well as absorbents, may also be traced upon the periosteum: although in a healthy state it appears to be insensible. The habitual production of osseous matter, after the bones have attained their perfect growth, takes place by laminæ, in the same manner as in their original formation, by a deposition from the periosteum. This mode of formation of bone from the periosteum may be very satisfactorily shewn, by feeding an animal with food mixed with madder. After a certain time, the bones are so impregnated with the madder as to be coloured by it. On leaving off the madder, the bone is observed to resume its natural appearance from without to within, which arises from a fresh deposition of bone from the periosteum. The colouring of the bone, according to Mr. Rutherford, is the result of a chemical affirmity existing between the colouring matter of the vegetable and the earthy particles of the bone. Mr. Gibson, of Manchester, does not, however, attribute this removal of the madder to the action of the absorbents, but to the peculiar affinity the serum of the blood has to the madder; which, although it at first conveys it to the bone, afterwards, when the animal's food is no longer impregnated with this substance, the preponderating affinity of the serum for the madder, deprives the earthy particles of it. It has also been shewn, by an experiment made by Mr. Hunter; who, on surrounding a bone with a ring, found that it gradually made its way towards the medullary canal of the bone; fresh depositions having taken place without, whilst absorption was going on in the interior.

The *medullary membrane*, which is highly vascular, contains the marrow, and serves as an internal periosteum to the bone it lines.

The *blood-vessels* of the bones are very numerous, and are sufficiently large to admit injection, so as not only to prove their existence, but even to indicate their minute course. They differ much in size, and are distinguished into those which first ramify on the external periosteum, and then penetrate the substance of the bone; and into such as, without first ramifying, penetrate at once into the medullary canal, and, spreading themselves upon the lining membrane, pass through its substance, and anastomose with the vessels of the compact structure. The *veins* which accompany the arteries, communicate very freely with the medullary cavities of the spongy structure of the bone.

Although *nerves* cannot actually be traced into bone, the pain incident to bones in disease sufficiently indicate their presence; and although, therefore, we have not, from our sensations, any consciousness of an osseous system, until some disease or accidental injury takes place in it, yet the bones are really as capable as any structure in the body of warning us promptly, through the medium of the nerves, of injury inflicted upon them by inordinate motion or weight.

Absorbents cannot be demonstrated passing into bones, but the phenomena attending exfoliation and other diseases, sufficiently indicate their existence in that system.

It may be observed, in conclusion, that the osseous system generally undergoes certain changes at the different periods of life. It is found more spongy and soft during infancy, only resembling a fibrous tissue, in which there may be observed the incipient deposition of earthy matter. As regards their external form, bones are generally found to have a more rounded shape during the earlier than the more advanced periods of life: their eminences and depressions are less marked, and their surfaces have, in general, a more uniform appearance. In early life their great flexibility is an important quality; for it is owing to this quality that external violence produces but a comparatively slight and transitory effect on the bones of a young person.

Chemical Composition of Bone.

Bone consists of animal and of earthy particles, which, according to some physiologists, are supplied by two distinct sets of vessels: the former, or animal particles, being secreted by the blood-vessels which supply the internal or medullary membrane of the bone; whilst the latter, or earthy particles, are deposited by those of the periosteum or external investing membrane. These two distinct constituents of bony substance may be easily demonstrated. For this purpose, if a portion of bone be exposed to a great heat, its animal particles will be consumed, leaving only an earthy residuum: whilst, on the other hand, if bone be submitted to the action of dilute (nitric) acid, its earthy particles will be removed, and with them the *hardness* and *density* of the bone, although the remaining animal matter will be sufficient to retain the original *form*. The hardness of bone depends upon the preponderance of the earthy over the animal particles, whilst the deficiency of earth proves the cause of morbid softness. It should, however, be observed, that the bones of the fœtus are naturally soft from an excess of animal matter.

The following is the analysis of bone as given by Berzelius:

Cartilage	34	17
Phosphate of lime	51	04
Carbonate of lime	11	30
Fluate of lime	2	00
Phosphate of magnesia	1	16
Soda, muriate of soda and water . .	1	20

Lime appears to be an essential ingredient in the formation of the skeleton of all animals, it is present in the bones of all the vertebrata, and in the shells and coverings of the testaceous and crustaceous tribes. Lime is never found in the animal system uncombined with an acid, either phosphoric, carbonic, or fluoric; the combination with phosphoric acid, is found in bone, while the carbonate of lime preponderates in shells. Lime is taken into the body with the food; but some are of opinion, that it is also generated; and bring forward as proofs of this hypothesis, the morbid calcareous concretions which sometimes occur in young subjects. In the shells of eggs also the quantity found in them far exceeds the actual quantity of the substance ingested. Bone, shell, cartilage, and membrane, all originate from the coagulable matter of the blood, and from the different proportions of its constituents, form either gelatine or albumen; the former is known by its solubility in water, at the temperature of 160$_0$, while in the other proportion, when it forms albumen, it coagulates instead of dissolving on exposure to heat; these two products of the blood form all the various tissues of the body. Thus membrane is gelatine, with a sufficient quantity of albumen to give it its tenacity. Cartilage is gelatine, with a greater proportion of albumen to give it its solidity; and bone is cartilage, with the deposition of lime, from which it acquires its peculiar characteristic hardness.

Messrs. Fourcroy and Vauquelin state, that phosphate of magnesia, which is found in the bones of the lower animals, does not exist in the bones of the human subject; whilst, on the other hand, this salt is found in human urine, but not in that of brutes.

The relative proportion in the constituent parts of bone is not the same throughout the skeleton, nor even in one and the same bone at different periods of life. It is to these circumstances that are to be ascribed the sensible changes observed to take place, as well in the colour as in the texture of bone, at the different ages of the human subject. Thus we find them blue and soft, in infancy; white and hard, in the adult; yellow and brittle, in old age. The yellow colour of the bones in old age is, however, in part owing to the deposition of an oily matter into their substance. In speaking of the composition of bones, it may not be improper again to allude to what may be numbered with their appendages. Externally, they are covered either by periosteum or cartilage; internally, by a medullary membrane. The periosteum furnishes a membranous covering to the bones generally. Cartilage covers the extremities of such bones only as are destined to enter into the construction of joints. The medullary membrane performs a two-fold function: it assists in the nourishment of the bone itself, and secretes the marrow contained within the interior of the bone. This marrow has an oily consistence, but does not present the same appearance or the same characters in all bones: in long bones it is solid and compact, in the short bones it is fluid; indeed, some have contended that during life the marrow is always in a fluid state, and only congeals after death, but in some bones sooner than in others. In the long bones the marrow is lodged within the medullary membrane; whilst in the short bones that membrane is wanting, the marrow being deposited in the cancellated structure of the bones themselves.

Marrow is formed at an early period of ossification: it is of a redder colour, and most fluid, in infancy: it becomes more copious, and more extensively diffused till adult age; and is supposed, by some, to assist in nourishing the body generally, and in decarbonising the blood.

Re-production of Bone.

The process by which bone is generated, after injury or disease, is precisely analogous to that by which the bones are originally produced. The vessels of the bones, and even the other structures surrounding them, if the separated parts be but approximated, soon throw out a gelatinous fluid, which hardens by degrees, and is in time converted into cartilage. In the interior of this cartilage, bony nodules are in a short time observed to form; which, uniting with each other as well as with the injured parts, form a medium of union for the detached portions; indeed, this process is observed to take place, even when the fractured parts are not brought into actual contact with each other, provided no solid substance intervenes. After the re-production of a part of a bone has been effected, the medullary cavity of that bone is found to be divided by a solid partition into two cavities, presenting an appearance as if the bone had originally consisted of two pieces. But after injury, the process of re-production does not always take place,—the failure depending upon either mechanical or constitutional causes, or both; such as a cachectic habit, or want of apposition, and rest of parts. Generally, however, it may be considered, that there is no solid in the body which has equally the power of re-production as bone; for, in solution of continuity, it soon repairs itself by a substance entirely resembling the original bone, not only in its form and texture, but also in its chemical composition.

Accidental Ossification.

There are certain of the soft structures of the body, which are liable to accidental or unnatural depositions of bony matter, as the dura mater, pericardium, and even muscle. It generally happens, however, that the proportions of the animal and earthy parts are not the same as in original bone. These deposits being sometimes as hard and polished as the enamel of the teeth, at other times soft and cretaceous, resembling moistened chalk. The former are most common on serous membranes, whilst the latter are not unfrequently met with in abscess of the lungs, in the uterus and ovaria.

Diseases of Bone.

The bones, as well as the softer parts of the human body, are liable to disease; and, like other parts, are susceptible of inflammation, and of the usual consequences of that process, whether it arise spontaneously or be caused by external violence. When they sustain a solution of continuity, the separated parts are susceptible of re-union, by a process of reparation analagous to that which takes place in the softer substances of the human body, when they are affected in a similar manner. Bones, however, fall more slowly into disease than the softer parts, and their restoration is proportionably more tardy: they receive their nutriment chiefly from the periosteum; and hence it is, that disease or injury to that membrane immediately affects the bone itself—a circumstance that should ever be borne in mind by the surgeon when operating upon bone; for it is scarcely possible that any very extensive destruction of periosteum can occur without exfoliation of the bone itself.

Although it is not my intention to enumerate all the diseases to which bone is liable, as I should then encroach upon the province of surgery, rather than adhere strictly to the duties of an anatomical writer, yet I would wish to direct the attention of my readers to the similarity of the diseased action of the bones, with every other structure in the body; and difficult as this task may appear to comprehend at a first view of the subject, still, if we remember that, even in structure, bone differs only from the softer parts of the body in having earthy matter superadded to its other constituent parts, the mystery is much diminished; and, moreover, it is found that the bones are liable to disease in proportion as their animal substance preponderates over their earthy particles.

Remarks.

The bones are not unfrequently rendered unfit to perform their natural functions, of supporting the weight of the body, and sustaining the action of the muscular system from an undue degree of softness, or hardness; the former disease being termed mollities, and the latter fragilitas ossium. These diseases depend upon a deviation from the natural proportions of the animal and earthy matter; in mollities the former, and in fragilitas the latter substance preponderating.

The dreadful distortions of the frame which are produced by the softness of the bones, are but too familiar to every medical practitioner, as well as the repetition of fractures of the bones in those subjects whose osseous system is unnaturally brittle. In either of these cases, constitutional remedies must principally be relied on; and chemical agents may be called in aid, perhaps, with more prospect of success, than in any other disease to which the human frame is incident. Mechanical means, as bandages, stays, splints, and such apparatus, will be found useful; but the surgeon should always bear in mind, that to the constitution, principally, his attention is to be directed.

The bones of all animals, it should be remembered, do not possess the same proportions of animal and earthy matter; for in such animals as enjoy great pliability, their bones are composed of an excess of animal matter, while, on the contrary, those which have to bear against superincumbent weight, and under the influence of powerful muscles, are furnished with a superabundant quantity of earthy matter. The pathologist may bear this fact in mind, together with the probable difference which exists in our own species, between the constituents of bone of the robust and weak; and thus the natural means to be employed for the restoration of the animal balance may be suggested.

The osseous system, when inflamed, undergoes very similar changes that increased action produces in the soft parts, and similar means are to be employed in subduing it.

The inflammation may be either acute or chronic, common or specific, and the strict antiphlogistic discipline, and counter-irritants, are the remedies to be adopted; with a severity to be regulated by the power of the patient's constitution. Calomel and opium will be found particularly useful when the pain is very urgent. It may be remarked, that the increase of pain at night, is one of the diagnostic marks of inflammation of bone, whether it be affected by simple or specific action; although it is too generally considered that the nocturnal pains indicate syphilitic affection, when on the contrary, it seems to be concomitant with inflammation of bone, from any cause. When the inflammatory symptoms have been relieved, or it has terminated by what is called resolution, a thickness of the inflamed bone remains, usually for a considerable time, from the difficulty there appears to be in the absorption of the adventitious earthy parts.

When the inflammation goes on to the formation of matter, suppuration is indicated by symptoms similar to the formation of matter in soft parts, although there is somewhat more difficulty in deciding upon it, as no external marks at first present themselves; but rigors, with an increased sense of weight of the diseased part, and a remission of the severity of the pain, will usually lead to a just diagnosis. But in abscess, the part of the bone affected soon becomes swollen, its periosteum becomes thickened, caries supervene, and the matter is discharged by a process similar to the discharge of matter from soft parts; but the progress and reparation is slower.

Caries, is the term given to the ulcerative process in bone, and principally attacks the short bones, and the spongy parts of the long bones.

Necrosis, differs from caries, the former corresponding to mortification, and the latter to ulceration of the soft parts; while *exfoliation* is the means by which living bone gets rid of that in a state of necrosis. This process is performed by the dead bone acting as an extraneous body upon the living, producing the action of its absorbents, which remove the earthy parts; so that the dead bone is separated from the living by cartilage, which forms a distinct line of demarkation between the dead and living parts. When a large portion of bone is affected by necrosis, it generally happens that new bone is formed around the dead, so as to maintain sufficient firmness of the limb to prevent complete solution of continuity of the bone, and frequently to support even the weight of the body during locomotion.

Bone, when deprived of its periosteum, is liable to exfoliate; but denuded bone need not, consequently, die; it depends upon the extent of separation of the periosteum, as well as upon the age and constitution of the patient. When exfoliation is going on, the remedies should principally be applied in reference to the living, and not to the dead bone, although mechanical means may sometimes be advantageously employed in removing the dead parts.

LECTURE II.

THE BONES OF THE HEAD.

Description of the Skeleton.

When the bones of any animal are placed in situ, and deprived of their soft parts, the whole is called a skeleton; which is termed natural or artificial, as they are attached to each other by their own ligaments, or by wires. The artificial skeleton is best adapted for anatomical observation, as it admits of the motion of the limbs, and therefore is more suited to give a just idea of their uses.

The human skeleton, as the skeletons of all mammalia, bears a strong resemblance to the figure of the body, and conveys at one glance a just idea, how admirably it is adapted to its particular uses, especially in regard to the defence which it affords to the vital organs. It presents two large cavities:—the superior one, produced by the flat bones of the skull, prolonging itself through the vertebral canal, lodges the whole of the central parts of the nervous system: while the large anterior cavity, formed by the bones of the thorax and pelvis, sufficiently guards the organs for respiration and nutrition.

The skeleton of the mammalia possesses a skull, the bones of which are united by sutures; jaws furnished with teeth, and the upper one fixed; two occipital condyles; seven cervical vertebræ; dorsal vertebræ moveable, and the pelvis, closed in front.

To facilitate the description, it is convenient to make of the skeleton three principal divisions,—*head*, *trunk*, and *extremities*—each of which are composed of several bones, so arranged as readily to indicate the functions for which they are destined.

The *head* is subdivided into the bones of the *cranium* and *face*, which will hereafter be particularly described.

The *trunk* is subdivided into the bones of the *spine*, *chest*, and *pelvis*.

The third division of the skeleton, the *extremities*, are divided into *superior* and *inferior*. The former are attached to the sides of the chest, and are composed of the bones of the *shoulder*, *arm*, *fore-arm*, and *hand:* while the inferior extremities, which are placed immediately under the pelvis, and give support to the rest of the body, are subdivided into the bones of the *thigh*, *leg*, and *foot*.

The Head.

By the head, is meant all the spheroidal portion of the skeleton, which is placed above the first cervical vertebra, and necessarily comprehends the bones of the cranium and face. The principal difference in the form of the head of the human subject and the lower animals, is in the preponderance of the area of the cranium to the face. The cranium consists of several bones, which, in conjunction, form a vaulted basin for the purpose of defending the brain and its membranes. This bony cavity is invariably of a capacity in proportion to its contents, and is necessarily variable in its size.

The roundness of the cranium renders it better fitted to protect as well as to support the vital organ it contains, and is produced by the equal pressure of the brain upon the bones during its developement: this roundness, however, is prevented in the lateral inferior regions of the skull, by greater hardness of the temporal bones, as well as by the action of the temporal muscles, which have a great power in producing this effect; for the skull does not acquire its flatness until the muscles are sufficiently strong to produce it,—hence the skulls of infants are much rounder than in after life.

The advantages derived from this lateral flatness, are an extended sphere of vision, and a more favourable position for the external organs of hearing.

The convex vertex of the cranium is quite smooth, and is covered by the pericranium, a thin aponeurotic expansion, and skin; while the external surface of the base is irregular, affording eminences and depressions for the attachment of the bones of the face anteriorly, and for muscles posteriorly. The internal surface of the cranium, offers no greater irregularities than to correspond with the uneven superficies of the brain, with some few grooves for lodging the blood-vessels of the brain, and its membranes.

It is worthy of remark, that the exterior table of the bones of the skull does not offer eminences corresponding to the internal depressions, in consequence of an intervening cancellated structure, but which, however, is diminished in those situations in proportion to the depth of the internal depressions—an observation pathologically valuable in reference to the application of the trephine.

In the base of the skull many outlets are found, termed *foramina*, allowing the transmission of nerves and blood-vessels.

It has already been observed, that the bones of the skull are composed of two laminæ, with an intervening cancellated structure, called the diploe; but it should further be noticed, that the external table is thick and fibrous, and the internal compact and thin: which circumstances tend to render the bones a better defence to the brain, upon principles which will be explained hereafter.

The cranium consists of eight bones; six of which are usually described as proper to its cavity, and two common to it and the face: but, upon consideration, it is difficult to understand the legitimacy of this division; for, in truth, the reverse seems to be the fact, namely, that only two, the parietal bones, can strictly be described as proper to the cranium, and the remaining six as common to the head and face.

The eight bones which enter into the composition of the cranium, are the *os frontis*, which occupies the anterior part of the skull; the two *ossa parietalia*, which form the upper lateral portions and vertex; the *os occipitis*, which is situated behind, and at the base; the two *ossa temporum*, forming the inferior lateral portions, and part of the base of the cranium; the *os ethmoides*, occupying the fore part of the base, which is completed by the *os sphenoides*, situated in the centre.

It may, moreover, be observed, that the frontal, occipital, ethmoid, and sphenoid, are azygos bones, and are placed in the mezian line of the body; while the parietal, and temporal bones are in pairs, and are situated laterally.

The bones of the head are connected with each other by sutures, of which I shall now give no further account than their names and situation, leaving their minute anatomical structure to be described under articulations in general.

The Sutures.

The sutures or seams connecting the bones of the head with each other, are fourteen in number; namely, the *sutura coronalis, sagittalis, lambdoidalis, squamosæ, additamenta suturæ lambdoidalis, additamenta suturarum squamosarum, sutura sphenoidalis, ethmoidalis, transversalis*, and the *suturæ zygomaticæ*.

These sutures connect the bones of the skull in the following manner.

The coronal suture connects the frontal with the two parietal bones: it begins at the anterior junction of the parietal bones, and extending downwards on each side, terminates in the squamous suture, about an inch behind the external angle of the orbit.

The sagittal suture connects the two parietal bones in the middle line of the vertex, extending from the coronal suture before, to the lambdoidal behind.

The lambdoidal suture commences at the posterior junction of the two parietal bones, connecting them with the os occipitis: it extends itself downwards on each side, as far as the posterior boundary of the squamous suture, and there seems to terminate; although a prolongation of this suture serves to connect the remaining portion of the occipital with the temporal bones, under the name of the additamentum suturæ lambdoidalis.

The squamous sutures, so called from one bone overlapping the other, extend from the coronal suture before, to the lambdoidal behind, uniting the temporal with the parietal bones. A continuation of this suture, uniting the temporal with the sphenoid bone, is termed, by some anatomists, the additamentum suturæ squamosæ; but it should be observed, that this overlapping of bones is not peculiar to the temporal bone, but appertains to all such bones as admit of the play of the temporal muscles over them.

The additamenta suturæ lambdoiadalis connect the petrous portions of the temporal bones with the occipital bone.

The additamenta squamosarum unite the petrous portions of the temporal bones with the sphenoidal angles of the parietal bones.

The ethmoidal, and sphenoidal sutures, form the rough circumferences of the bones whose names they bear, and connect them with the other bones of the head.

The transverse suture connects the os frontis with the bones of the face, and will be more particularly pointed out, as will the other sutures, in the description of the union of the several bones of the face.

Having now taken a collective view of the bones of the skull, as far as refers to their junction, we shall proceed to their individual description.

The Os Frontis,
(Frons, Forehead.)

Has its name from its alone forming that portion of the head we call the forehead. It has some resemblance to the cockle-shell when separated from the other bones: it is *convex* externally, and *concave* internally: smooth above, where it forms the forehead, but below, where it assists in forming the orbits, it affords several processes and eminences: the inner concave or cerebral surface is turned towards the brain. The processes and depressions which may be remarked on the external surface are, first, *two frontal eminences,* which mark the centres of ossification; *two frontal tuberosities,* marking the situation of the frontal sinuses; and *two superciliary ridges*, which overarch the orbit, give attachment to the occipito-frontalis muscle, and have the eye-brows placed on them, the space between them being termed the glabella; the superciliary ridges terminate externally and internally in an *external* and *internal angular process.*

Betwixt the two internal angular processes, a small process arises named the *nasal process.* Behind the external angular processes, a flat surface is observed, denominated the *temporal fossa*, on which the temporal muscle plays. From the under part of the superciliary ridges, portions of bone are directed a considerable way backwards: they are concave below to receive the ball of the eye, and termed therefore the *orbitar processes.* In each of the orbitar processes, upon the outer part of their concave surface, behind the middle of the superciliary ridge, is a *depression* for the lachrymal gland: *a small pit*, the fovea trochlearis, may be seen behind the internal angular process, where the pulley is fixed for the tendon of the superior oblique muscle of the eye to play around. Betwixt the two orbitar processes there is a large *fissure*, into which the cribriform plate of the ethmoid bone is admitted.

The *foramina*, observable on the external surface of the os frontis, are one on each side proper, and two common to the frontal and ethmoid bone:—*One* on each superciliary ridge, a little on the inner side of its centre, named the *supra orbitar foramen*, which gives passage to a twig from the opthalmic branch of the first division of the fifth pair of nerves; and a small branch from the internal carotid artery, to be distributed to the integuments and muscles of the forehead: but this opening is often found as a notch only. Near the middle of the inner edge of each orbit or process, sometimes formed in the transverse suture, where that suture attaches the orbitar process of the frontal with the ethmoid bone, is situated the *foramen orbitarium internum anterius*, which transmits the nasal twig of the first branch of the fifth pair of nerves, and a branch of the opthalmic artery. About an inch behind this, the *foramen orbitarium internum posterius* is placed, which is smaller than the anterior one, and through it a small branch of the occular artery passes to supply the dura mater. Besides these there are a great number of small holes, which mostly only penetrate the first table, and admit of small vessels to the diploe, and the frontal and ethmoidal sinuses.

The *internal* or *cerebral surface* of the os frontis is *concave*, excepting at the orbitar processes, which are *convex*, to support the anterior lobes of the brain: its surface is not so smooth as the external, for the arteries of the dura mater, and the irregular surface of the brain, furrow it. Through the middle of the internal surface, on the anterior half, there is a *ridge* for the attachment of the falx major, and through the posterior half, a sulcus for the lodgement of the superior longitudinal sinus. Immediately at the root of the ridge, anteriorly, there is a hole called the *foramen cœcum;* in this a small process of the falx is situated, and the superior longitudinal sinus begins; this hole is sometimes formed partly by the crista galli of the ethmoid bone, so as to render the foramen common to the two bones. Small depressions are also formed in the central surface of the os frontis, which lodge the glandulæ pacchioni, and are called the foveæ pacchioni, they are situated on either side of the longitudinal groove.

The os frontis is composed of two tables and an interposed diploe; it is nearly equally dense throughout, excepting at the orbitar plates, which are rendered thin by the pressure of the brain on one side, and the globe of the eye on the other. In that part above the superciliary ridges, where the frontal tuberosities are described, the *frontal sinuses* are situated: they are formed by a separation of the external from the internal plate, and the absence of diploe; they are divided by a bony partition, but generally not into equal sized cavities,—the partition is by no means always perfect. The frontal sinuses open into the middle chamber of the nose.

Connexion.—The upper circular part of the os frontis is joined to the ossa parietalia, from one temple to the other by the coronal suture; from the termination of the coronal suture to the external angular process, it is connected with the sphenoid by the sphenoidal suture; at the external canthi, its external angular processes are joined by the transverse suture to the ossa malarum, to which it adheres one third way down on the outside of the orbits; whence to the bottom of these cavities, and a little upon their internal sides, the orbitar processes are connected with the sphenoid bone by the same suture. On the inside of the orbit, the ethmoid and the unguis are joined to the orbitar plate of the frontal bone. The transverse suture, afterwards, joins the frontal bone to the nasal processes of the superior maxillary bone, and to the nasal bones; and lastly, its nasal process is connected with the ethmoid bone.

Use.—Serves to defend and support the anterior lobes of the brain; assists in forming the bony part of the organs of vision and smell. In the fœtus it is not perfectly ossified; the superciliary holes are not formed; nor are the frontal sinuses. In the second month of uterine gestation the frontal bone consists of two lateral portions, and their union usually is not complete until the second year after birth; and a suture sometimes remains through life.

Attachment of Muscles.—The muscles arising from the frontal bone are the temporales, corrugatores superciliorum, and the orbiculares palpebrarum, and inserted into it, the occipito-frontalis.

Points of Practical Importance connected with the Frontal Bone.

The *frontal eminences* are not to be considered as merely the points at which ossification commenced, but from their projecting form, and necessarily greater quantity of bony matter, as affording an additional defence to the anterior part of the brain.

Frontal prominences, which mark the situation of the frontal sinuses, do not offer the same dangerous symptoms from depression, in consequence of fracture, as other parts of the bone; because of the separation of the laminæ in this situation. Bleeding at the nose, and extravasation of air, are the diagnostic marks of this accident. A mucous membrane lining the frontal sinus, renders this part liable to disease incident to the membrane. Thinness of the orbitar process leaves the brain dangerously accessible to a sharp instrument entering the orbit. The projection of the frontal spine in the interior middle line of the bone, and the continued groove for lodging the superior longitudinal sinus, excepting under unavoidable circumstances, unfit this part of the bone for the application of the trephine.

The Ossa Parietalia,

(Paries, a Wall.)

Are two bones completely proper to the cranium, and forming its vertex, in shape of an irregular square; and when connected, form an arch with its convexity placed externally, and its concavity internally. In many animals, as in the cheiroptera and carnivora, they form but one bone. There may be distinguished upon each of these bones the following parts:—an *external* and an *internal surface, four edges,* and *four angles,* as well as certain *eminences* and *depressions.*

The *external* surface of the bone is *convex,* more especially in the centre, where a prominence, termed the *tuber parietale,* marks the commencement of ossification; immediately below the prominence is situated an *arched ridge,* crossing from before to behind, from which *radiated lines* pass down, converging towards the inferior edge, marking the attachment of the temporal muscle. The four edges of the bone are the *superior* or *sagittal edge,* which is serrated, and assists to form the suture common to both. By the side of this edge, near the centre, a *foramen* is formed, which transmits a vein, passing to the superior longitudinal sinus. The *anterior* or *coronal* edge, also serrated, forms, with the frontal bone, the coronal suture: the *posterior* or *lambdoidal* edge being in a similar manner connected with the occipital bone. The *inferior* or *squamous* edge differs from the others in being grooved, and is overlapped by the temporal bone.

The four angles are, the *anterior and superior,* or *frontal angle,* which is the shortest of any, and for some months after birth are so truncated as to leave a space uncovered by bone, which is termed the fontenelle; the *anterior* and *inferior,* or *sphenoidal angle,* which is the most lengthened of the four;

the *posterior* and *superior*, or *occipital angle;* the *posterior* and *inferior*, or *mastoidal angle.* The whole of the external surface of the bone is smooth, excepting at the edges.

On the *inner concave* surface, deep furrows are formed by the vessels of the dura mater; and at the anterior and inferior angle, there is a canal for the middle or meningeal artery of the dura mater: there are also several small holes leading to the diploe. Generally the lateral sinuses make a *depression* at the posterior and inferior angle of the bone: also a sulcus, which by conjunction of this bone with its fellow, forms a groove, is seen at the superior edge, and lodges the superior longitudinal sinus.

Sinuosities, for the lodgment of the prominent parts of the brain, present themselves on this surface.

Connexion.—The ossa parietalia are the thinnest of the bones of the head, but have every where the diploe. They are *joined in front,* to the os frontis, by the coronal suture; at their inferior angle, to the *sphenoid bone,* by part of the suture of this name; at their *lower edge,* to the ossa temporum, by the squamous suture; *posteriorly,* to the os occipitis, by the lambdoidal suture; and *above,* to one another, by the sagittal suture. At the time of birth these two bones are separated from each other, and the opening is called the *bregma:* the pulsation of the brain may be felt here through the membranes.

Use.—The parietal bones form the superior, middle, and lateral parts of the skull; and are destined therefore to protect the superior parts of brain from injury, and to lodge a part of the longitudinal, and lateral sinuses.

Attachment of Muscles.—Only one muscle is attached to the parietal bone, the temporal; the tendon of the occipito-frontalis passes over it.

Practical Remarks.

The ossa parietalia are more frequently fractured than any of the other bones of the head, and generally near their junction with the temporal bones.

The application of the trephine should be avoided upon the two inferior angles of these bones: upon the anterior and inferior, in consequence of the situation of the middle meningeal artery of the dura mater; whilst the proximity of the lateral sinus to the posterior and inferior angle, would render its application there dangerous. The superior longitudinal sinus must also be avoided; and, indeed, the variety in the thickness of the bone, in its different parts, would imply the necessity for great caution in the application of the trephine.

During parturition, a judgment may be formed as to the life of the fœtus, by the presence or absence of pulsation at the fontinelle.

The Os Occipitis.

(Ob, Behind. Caput, the Head.)

This bone forms the posterior paries of the cranium, and also a portion of the base. It derives its name from its situation; and, like the other bones of the skull, presents an external convex and an internal concave surface. Its figure is rhomboidal, having the upper angle slightly rounded; the two lateral angles are obtuse, while the anterior one projects forwards, forming a part of the base of the skull, and is connected with the sphenoid bone.

The form of this bone produces one of the greatest varieties in the configuration of the skulls of different animals, and seems to depend upon the strength of the lower jaw, and the developement of the muscles of mastication.

The occipital bone is, at birth, divided into four distinct portions: the upper of these is the largest, comprising all that part of the bone situated above the foramen magnum: its shape is triangular. The two lateral portions are symmetrical, and are situated at the side of the great foramen, and constitute the condyles. The fourth piece forms the anterior part of the bone, completes the foramen, and projects forwards to form the cuneiform process. The description of the bone is facilitated, by giving a distinct anatomical account of each of these parts separately.

The *occipital*, or *upper portion*, presents an *external* convex surface,—the upper half of which is smooth, for the play of the occipito frontalis muscle, while its lower half is rough, for the attachment of strong muscles, which support the head in the erect posture: we observe also two *transverse arched ridges*, a superior and an inferior. In the centre of the superior is a prominence, called the *external tubercle* of the occipital bone; and extending downwards from the tubercle, in the median line, as far as the foramen magnum, we find a sharp ridge, called the *occipital spine*. This spine bisects the inferior arched ridge, and is most prominent at the lower part. On either side of the tubercle, and between the arches, the bone is rough for the attachment of muscles, which are connected in the following order:—To the upper transverse ridge are attached the m. occipito-frontalis, the m. trapezii, and part of the m. sterno-cleido-mastoidei. The space between the arches is occupied by the m. splenii, and m. complexii; while into the inferior are inserted the m. recti capitis postici majores, and m. obliqui capitis superiores. Immediately above the foramen magnum, and on either side of the spine, are two slight pits, which receive the insertions of the m. recti capitis postici minores.

The *internal surface* of this upper portion of the occipital bone presents a concavity, divided into *four compartments* by a *perpendicular* and an *horizontal groove*, which bisect each other at right angles. At the point where they cross is situated an *internal occipital tubercle*, below which the vertical groove generally forms only a spine, termed the internal occipital spine, and is continued down to the foramen magnum; it gives attachment to the falx minor. To the groove above the tubercle is attached the falx major, and within it is lodged the superior longitudinal sinus; while the lateral grooves give connection to the tentorium, and receive the lateral sinuses in their cavities. Above the tentorium, and consequently above the lateral grooves, the posterior lobes of the cerebrum are situated; and in the concave compartments below, the cerebellum is lodged. The whole circumference of this portion of the bone is serrated to form the lambdoidal suture, frequently presenting irregularities from the presence of ossa triquetra—bones rarely found in the inferior animals.

The *lateral parts*, or *condyloid portions* of the occipital bone, are, *externally*, irregularly convex; *internally*, irregularly concave. On their convex surface are seen the projecting processes called *condyles*, which articulate with the atlas. They have their long axis, from before to behind; converge anteriorly; and have their inner edges deeper than their outer, to prevent lateral motion. A rough line marks the circumference of the condyles, for the attachment of the capsular and lateral ligaments connecting this bone with the atlas. Behind each condyle is a fossa, from which open the *posterior condyloid foramina*, giving transmission to veins passing from the exterior of the cranium to the sinuses of the brain. On the outer side of the condyles we find an *irregular projecting portion of bone*, rough on the external surface, for the attachment of the m. rectus capitis lateralis, and marked within by a deep *sulcus*, which lodges the termination of the lateral sinus: its edges are rough, to connect it with the petrous portion of the temporal bone; and anteriorly it is hollowed out into a notch, which forms part of the *foramen lacerum basis cranii*. To the inner side of this notch, and immediately before the condyles, are the *anterior condyloid foramina*, for the transmission of the lingual nerves.

The fourth, or *cuneiform portion* of the occipital bone projects forwards from the foramen magnum, and seems produced by the junction of the lateral pieces. It is, as its name implies, of a wedge-like shape; its narrowest portion being situated anteriorly, where it is connected with the sphenoid bone. The posterior extremity of this process is concave, forming the anterior part of the foramen magnum: the anterior extremity is rough, for its union with the sphenoid bone. Laterally it presents *irregular edges*, where it joins with the petrous portions of the temporal bones; and here a partial *groove* may be seen, completed by the temporal bone, for lodging the inferior petrosal sinuses. The *internal surface* of this portion of the bone is smooth, and slightly *hollowed*, to receive the medulla oblongata: the *exterior* is rough, giving insertion to the m. recti capitis antici majores et minores: anteriorly to which are attached also the superior and middle constrictors of the pharynx, of which cavity this bone forms the upper boundary.

The junction of these four portions of the occipital bone with each other, forms that large opening called the *foramen magnum;* which is, consequently, bounded before by the cuneiform, behind by the occipital, and laterally by the condyloid portions. The *foramina*, which we have already noticed, should now be described collectively: they consist of two pair and a single one *proper* to the occipital bone, and one pair *common* to it and the temporal bones.

The *proper*, are the *foramen magnum*, and the *anterior and posterior condyloid foramina*. The foramen magnum transmits the spinal marrow with its membranes and vessels, and allows the entrance of the vertebral arteries and accessory nerves. The anterior condyloid foramina are important, from giving transmission to the lingual nerves: the posterior merely allow the passage of small veins, and are occasionally wanting, in which case the veins pass through the foramen magnum, to give the lateral sinuses. The pair of foramina *common* to this bone and the temporal, are the *foramina lacera basis cranii;* giving exit to the internal jugular veins, the pneumo-gastric, glosso-pharyngeal, and accessory nerves. These foramina are sometimes divided into two by a thin lamina of bone.

Connexion.—The occipital bone is connected above, with the ossa parietalia, by the lambdoidal suture; latterally, with the temporal bones, by the additamenta suturæ lambdoïdalis; and anteriorly, by the extremity of the cuneiform process, with the sphenoid bone, in the same way that epiphyses and their bones are joined: for, in the young subject, a cartilage is placed between them. Lastly, it is connected below, by a double articulation with the atlas, each condyle being received into the superior articulating cavity of that vertebra.

Attachment of Muscles.—Muscles arising from the os occipitis. Occipito frontalis, trapezii, and constrictor pharyngis superior. Muscles inserted,—the sterno cleido mastoidei, splenii, complexi, recti capitis postici majores, minores, et laterales, obliqui superiores, recti capitis antici majores, et minores, and constrictor pharyngis medius.

Practical Remarks.

The variety of thickness in this bone should be kept in mind while examining it in case of injury. The ossa triquetra, which are insulated portions of bone produced by variations in the course of the lambdoidal suture, sometimes offer such irregularity of surface, as might lead to a suspicion of injury to the bone where it did not exist. From its connexion with the first cervical vertebra, this bone differs from all those already described, by its liability to the diseases incident to moveable articulations.

The only situation in which the trephine can be safely applied to this bone, is in the space above the tubercle on either side of the median line, in consequence of the situation of the sinuses, above, and the thick layer of muscles below the transverse ridge.

The Ossa Temporum,
(Tempus, Time.)

Are situated at the sides and inferior part of the cranium, containing within them the organ of hearing: they are said to be so called from the hair situated on them first becoming grey, and thus denoting age in the individual. Each os temporis may be divided into two portions: the upper one thin and smooth, terminates in a semi-circular edge, which, from its peculiar connexion with other bones, is called the *squamous* portion. The lower portion, situated at the base of the skull, is hard, and forms a protuberance irregularly triangular: this contains the organ of hearing, and is denominated the *petrous portion.*

These bones present an external irregularly convex, and an internal concave surface.

There are five processes on the external surface of each temporal bone which may be described: the first, situated at the lower and posterior part of the bone, is called, from its resemblance to a nipple, the *mastoid process:* this is externally hard, but is composed internally of cancelli, which have communication with the cavity of the tympanum: it has three muscles attached to it: the sterno-cleido mastoideus, trachelo-mastoideus, and splenius—all inserted into it. Anterior to the mastoid, a second process arises out of the bone: it is directed obliquely forward, about *two inches* in length, and terminates by joining the os malæ, forming an arch under which the temporal muscle passes: this is called the *zygomatic process.* The upper edge of this process is somewhat rough, for the attachment of the strong aponeurosis of the temporal muscle, and the lower edge has arising from it a part of the masseter muscle. From the under part of the bone, below and between the other two processes, the third process projects, pointing downwards, and from its form is denominated the *styloid process:* it is various in its length in different subjects, and is sometimes found, in advanced age, to be of such a length as to be connected by bone to the os hyoides. Three muscles have their origin from this process, and are partly named from it:—The stylo-glossus, stylo-hyoideus, and stylo-pharyngeus: a ligament of the os hyoides is also attached to it, a portion of which extends to the angle of the jaw. This process in youth is principally cartilage, and at the adult period is frequently not entirely ossified.

These are the three principal processes of the temporal bone: but there are still two others, which, as they are invariably present, should be mentioned. Round the root of the styloid process, but more particularly anteriorly, there is a remarkable rising of bone which is called the *vaginal process:* it is rough, and gives attachment to the internal lateral ligament of the lower jaw.

The fifth process is the *auditory*, which is irregular, and assists in giving a firm attachment to the cartilages of the ear, as well as to the external lateral ligament of the temporo maxillary articulation: it reaches from the anterior part of the mastoid, to the root of the zygomatic process, and forms the lower part of the rim of the *meatus auditorius externus.*

Five *depressions*, or *fossæ,* are observable on the external surface of each temporal bone.

A considerable fossa is found immediately on the inner side of the mastoid process, from which the digastric muscle arises; hence it is termed the *fossa digastrica.* Also anterior to the root of the zygomatic process, the *fossa temporalis* is situated, which depression marks the position and even the direction of the fibres of the temporal muscle: it is this depression which forms the posterior boundary of the zygomatic arch. Between the auditory, vaginal, and zygomatic processes, there is found a large cavity divided into two distinct fossæ by a fissure termed the *fissura glasseri:* the anterior fossa is lined with cartilage and receives the condyle of the lower jaw, hence denominated, the *fossa condyloidea*, the long axis of which is from side to side, corresponding to the form of the condyloid process of the lower jaw. The posterior fossa lodges a considerable portion of the parotid gland, and is termed the *fossa parotidea.* These fossæ are separated from each other, not only by the fissura glasseri, but also by the attachment of the capsular ligament of the temporo-maxillary articulation. The fifth fossa is the *fossa jugularis:* it is placed immediately on the inner side of the styloid process, whence begins the internal jugular vein from the termination of the lateral sinus.

The particular use of these depressions is sufficiently explained in the description given in each of them.

The *foramina*, which are usually found upon the external surface of the temporal bone, are five in number, and are *proper* to it: but, besides these are to be borne in memory, the notches which are formed into foramina, *common* to the temporal and other bones, to which it is connected, as the foramen lacerum basis cranii anterius, et posterius, and the canalis caroticus.

The five foramina proper to the temporal bone are, first, the *foramen auditivum externum*, which is situated between the mastoid and zygomatic processes, immediately above the auditory: this foramen leads from the external ear to the cavity of the tympanum, it gives attachment to the cartilages of the ear, and conveys sound to the bones of the internal ear. It is frequently termed the meatus auditivus externus.

The second foramen is situated between the styloid and mastoid processes, and is consequently called the *foramen stylo-mastoideum:* it is, in fact, the termination of the canal of Fallopius, and allows of the transmission of the portio dura or facial nerve.

Somewhat anterior, and rather to the inside of the styloid process, is found the third foramen, but which, from its tortuous course, is to be considered rather as a canal. It is through this foramen that the internal carotid artery enters the skull, and is termed, therefore, the *foramen caroticum.* It also admits the filaments of connexion between the sympathetic and the fifth and sixth pairs of cerebral nerves: there are small foramina leading from this passage to the internal ear, and, through these, small arteries pass, which have been particularly described by Valsalva as the proper arteries of the tympanum.

On the anterior edge of the sqamous portion of the temporal bone, at the very point of junction of this part of the bone with the petrous, is placed the orifice of a canal which passes backwards and outwards to terminate in the anterior part of the tympanum: in the recent subject, partly composed of cartilage and partly ligamentous, it is continued to the pharynx, and is termed the *iter a palato ad aurem,* or *eustachian tube.* Immediately above the entrance of the eustachian tube, and separated from it by a thin lamina of bone, is a small canal of minor importance, through which the tendon of the tensor tympani muscle passes into the tympanum.

The fifth foramen is the *foramen glasseri,* which is situated a little above the centre of the fissure of that name, immediately posterior to the capsular ligament of the lower jaw: it allows of the passage of a small nerve which crosses the tympanum, and is termed the chorda tympani: it likewise gives entrance to the tendon of the laxator tympani muscle. There is, however, not unfrequently, another foramen found on the external surface of the temporal bone, just at the posterior rough edge of the petrous portion, which is called the *foramen mastoideum:* but this foramen is usually commom to the temporal and occipital bones. Its use is to transmit a small vein from the exterior of the cranium to the lateral sinus, and sometimes a small branch of the occipital artery passes through it to supply the posterior surface of the dura mater.

The *internal surface* of the ossa temporum is very unequal, but, like the external, is divided into a squamous and a petrous portion. The squamous portion is irregularly concave, rises upwards, and terminates in a thin semilunar edge, which is serrated for its firmer attachment to the parietal bones which it overlaps, producing that kind of scaly attachment from which this portion of the bone has derived its name. Immediately below the scaly serrated edges, the bone is marked by the convolutions of the lateral lobes of the brain, and is furrowed by the arteries of the dura mater.

The petrous portion, on its internal surface, is of a triangular form, and is directed forwards and inwards, presenting an anterior surface, a posterior surface, an acute upper edge, and a broad surface below, which is irregular, and has been described as forming a part of the exterior of the bone: the base of the triangle is attached to the squamous portion of the temporal bone, and the apex extends to the sphenoid, where that bone is joined to the cuneiform process of the occipital. On the *anterior face* there are irregular *depressions* to receive the middle lobes of the brain: there is also a *slight depression* for the semilunar ganglion of the trigeminal or fifth pair of nerves. At the anterior and internal extremity of this face, the *carotid canal* may be seen opening into the cavity of the cranium by the side of the sphenoid bone; and on the outer side of this, at the junction of the petrous and squamous portions of the bone, the *eustachian canal* is placed, which has already been described: leading from it, and directed upwards and outwards, passes *a groove* to the *foramen innominatum*, for the passage and transmission of a reflected branch from Meckell's ganglion. On the posterior surface may be seen the *foramen anditivum internum*, which allows the transmission of the portio mollis and the portio dura; the former passing to the labyrinth of the internal ear, while the latter takes its course through the canal of Fallopius, and passes out of the foramen stylo-mastoideum, as the facial nerve. The inferior edge of this surface forms a groove for the inferior petrosal sinus, which takes its course from before to behind, and terminates in the foramen lacerum basis cranii. There are also two small foramina seen on this surface of the bone: the first is placed immediately behind the foramen auditivum internum; it is leading from the vestibule of the internal ear, and is termed the *aquæductus vestibuli*. The other is rather to be described as being situated upon the inferior broad face of the bone, between the fossa jugularis and the carotid canal, being a passage from the cochlea, and is denominated the *aquæductus cochleæ*. These passages are supposed to be for the purpose of allowing the fluid, contained within the internal ear, to flow into the interior of the skull, when impressed by any violent sounds. The acute upper edge has, running from before to behind along its anterior half, a *groove* for the lodgement of the superior petrosal sinus, which leads downwards and backwards to terminate in the lateral sinus, immediately above the fossa jugularis; while, on the posterior surface of this acute edge, there are seen unequal convexities, marking the situation of the semi-circular canals. The *base* of the triangle is attached to the squamous part of the temporal bone; but immediately behind this junction, upon the internal surface of the mamillary process, is to be observed a deep *sulcus* for the lateral sinus. The apex of the triangle passes forwards to the sphenoid bone, and is rough in the recent subject, having cartilage connected with it.

The *foramina* of the temporal bone are to be divided into those which are proper, and those which are common to the temporal and other bones of the head.

The *proper* foramina are ten in number; five on the external surface, and five on the internal surface of the bone.

The external are the foramen auditivum externum, foramen stylo-mastoideum, foramen glasseri, foramen caroticum, and foramen eustachii.

The internal are the foramen auditivum internum, foramen innominatum, aquæductus cochleæ, aquæductus vestibuli, and the internal opening of the carotid canal, which is common to the temporal and sphenoid bones.

The *common* foramina are the foramina lacera basis cranii anteriora et posteriora, and the foramen mastoideum, which is sometimes, however, proper to the temporal bone; it is for the transmission of small veins from the exterior to the lateral sinus.

Connexion.—The temporal bone is joined by the upper and middle part of its thin serrated squamous edge to the parietal bone, while the anterior edge of the squamous plate connects it with the ala major of the spenoid bone; at its mastoid process, by the additamentum suturæ lambdoidalis, it is joined to the occipital bone; and by the anterior extremity of the zygomatic process, to the malar bone. The petrous portion, in forming its part of the internal base, is connected anteriorly with the sphenoid and posteriorly with the occipital bone, while the apex is indirectly connected with the body of the sphenoid bone by cartilage: and lastly, by the glenoid cavities the temporal bone is articulated to the lower jaw.

Attachment of Muscles.—Arising from each temporal bone are the m. masseter, temporalis digastricus, stylo glossus, stylo pharyngeus, stylo hyoideus, levator palati, tensor tympani, levator tympani, stapedius, retrahens aurem and the anterior auris.

Inserted into each, the m. sterno cleido mastoideus, splenius capitis and trachelo mastoideus.

Use.—The temporal bones assist the other bones of the cranium in protecting the brain, and by the peculiar manner in which they are joined to the sphenoid and parietal bones, they offer every defence against injury from external violence; they form also foramina for the transmission of vessels and nerves, and produce, with the lower jaw, the temporo-maxillary articulation: by their junction with the malar bones a portion of the face is produced; and lastly, they contain the organ of hearing.

In some animals, as in the horse, dog, and cat, in the ruminantia and rodentia, the portion of the temporal bone, which contains the cavity of the tympanum, is separated from the rest of the bone by suture, and in the cetacea it is connected only by soft parts.

The Practical Points

Connected with the temporal bones are numerous, as we should be led to suppose when considering the important organs connected with them; as, for instance, the organ of hearing; rendering these bones therefore subject to the diseases of mucous membranes, and of the articulations of the small bones of the ear. In the treatment of these diseases I cannot refrain pointing out, as a caution, the close vicinity of the brain.

Fracture of these bones is usually indicated by bleeding from the ear.

Their connexion with the lower jaw renders them also liable to the diseases and injuries of their connecting articulation; and when the lower jaw is dislocated, the position of the condyle should be remembered under the zygomatic arch, the posterior tubercle of which assists in forming the glenoid cavity.

From the proximity of numerous important parts to these bones, as the parotid gland, arteries and nerves, sinuses of the brain, and numerous muscles, the physiology and anatomy of the temporal bones should be particularly studied.

The covering which these bones receive from the temporal muscles, tends much to protect them from fracture; but when the accident does take place, owing to the brittle and compact structure of the squamous portion, the bone is generally so comminuted as to allow of the removal of the broken pieces by the forceps and Hay's saw, thereby rendering the application of the trephine unnecessary.

The Os Spenoides.

(σφην wedge ειδοσ likeness.)

This bone is excessively irregular in its form, so much so as to render it difficult to describe its figure. It has been thought to resemble, and has therefore been compared to the form of a bat, with its body, wings, and legs. It has derived its name from the manner in which it is wedged into the base of the skull.

It presents an irregular external *convex* surface, offering numerous eminences and depressions; and an internal *concave* one, more or less flattened or hollow, to receive the under surface of the middle lobes of the brain.

The external surface, at first view, offers three principal parts: the middle part, or *body*, the two *extending wings*, and the descending *legs*. As each of these parts presents numerous processes and depressions, I shall separately describe them.

The body forms the centre of the external surface of the bone, and offers an *anterior edge*, a *posterior surface*, and an *inferior surface*, the superior surface not being described until speaking of the internal part of the bone.

The anterior edge is serrated, for its attachment with the ethmoid bone; immediately posterior to which edge are seen small cellular cavities, which complete the posterior ethmoidal cells by their junction with the ethmoid bone. The posterior surface is rough, for its articulation with the occipital bone. The inferior surface of the bone presents, in its median line, a projecting process of bone termed the *azygos process;* which is produced by the junction of two thin plates of bone, termed the ossa triangularia, which cover the sphenoidal sinuses. This process projects upwards so as to divide the sinuses into two unequal parts, and downwards to form a part of the septum of the nose, by being received into the vomer. Laterally, the body of the bone is connected with the alæ and the legs.

The two *extending wings*, or *alæ majores*, stretch outwards to form the lateral boundaries of the bone, offering numerous irregularities for the attachment and lodgement of important parts, rendering their description essential. Upon the anterior and larger part of each wing we observe two smooth surfaces, separated by a middle ridge, to which the name of processes are given. The external surface is hollowed, forming a part of the temporal fossa, and is therefore termed the *temporal process:* the inner surface is also slightly hollowed, forms the outer part of the bony orbit, and is called the *orbitar process:* and the middle ridge is rough, for its attachment to the malar bone, and is denominated the *malar process*. Behind this is a groove for the passage of a nerve from the second division of the fifth pair. The posterior part of the ala major passes backwards, in a wedge-like form, to be admitted between the squamous and petrous portions of the temporal bone, under the name of the *spinous process;* projecting downward, from which is a little process termed the *styloid process*, giving origin to the m. circumflexus palati. The outer edge of the wing forms a semilunar serrated edge, for its attachment to the squamous portion of the temporal bone ; but it should be observed, that the anterior part of this edge is overlapped by the temporal bone, while the posterior part, in its turn, overlaps the temporal. By which arrangement great mechanical strength is given to their union. The internal edge of the ala major is connected with the body of the bone, and forms anteriorly a part of the foramen lacerum orbitale superius.

The last processes to be observed on the exterior of the sphenoid bone are the descending plates, commonly called the *pterygoid processes.* These processes come off from the junction of the body with the wings, and pass downwards perpendicularly from the base of the skull: they each consist of two plates, an external and an internal, joined together anteriorly, but separated behind, so as to form a hollow between them called the *pterygoid fossa,* the concavity of which faces backwards: this fossa is filled up by the origin of the pterygoideus internus muscle. At their lower part the plates cease to be joined anteriorly, and rather diverge from each other to their termination: the space thus left between them is, however, filled up by the pterygoid process of the palate bone. The external plate of the pterygoid process is the shorter and the broader, presenting an external surface, giving origin to part of the pterygoideus externus muscle, and an internal surface for the formation of the fossa. The internal plate is long and narrow, terminating in a slender curved projection called the *processus hamulus,* over which plays the tendon of the circumflexus palati muscle: its external surface corresponds to the fossa; its internal surface forms the posterior part of the inner wall of the cavity of the nose. At the anterior part of the pterygoid process, where the two plates are joined, we find, above, a slight concavity forming the posterior boundary of the spheno-maxillary fossa, a space between the sphenoid and maxillary bones, in which is lodged the superior maxillary nerve prior to its division. Extending downwards from this is a groove forming a part of the pterygo-palatine canal, and leading through the palato maxillary foramen to the roof of the mouth. On either side, and below this groove, the bone is rough for its attachment to the os palati. Lastly, the root of the pterygoid process is traversed by the pterygoid canal, extending from before to behind, which allows of the transmission of a branch of the second division of the fifth pair of nerves.

We may now proceed to speak of the internal surface of the sphenoid bone, which presents, besides the internal view of the body and wings, which have already been noticed as regards their exterior, also a third process, or rather a pair of processes, not yet spoken of, the *alæ minores,* or *processus ingrassias.* Thus, in giving a general description of the sphenoid bone, we might say that it consisted of a body and the alæ majores *common* to both its surfaces; of the pterygoid processes *proper* to the external; and the alæ minores, *proper* to the internal surface. The *internal surface* of the sphenoid bone is irregularly concave, and supports the middle lobes of the brain.

On the *body* we observe a considerable hollow, called the *sella tursica*, from its resemblance to a Turkish saddle,—or *fossa pituitaria*, for lodging the pituitary gland of the brain. This fossa is bounded anteriorly by two small projecting processes of bone, termed the *anterior clinoid processes:* they are produced by portions of the roots of the alæ minores, and between them is situated a rounded ridge of bone, called the *processus olivaris;* from which are seen to pass two diverging grooves, which lead to the foramina optica, and mark the course of the optic nerves after they have formed their junction. Behind, the fossa pituitaria, is bounded by the *posterior clinoid processes*, which project but slightly from an intervening plate of bone, which connects them one to the other in such a manner as to present generally rather a single than a double process.

At the sides of the sella tursica, running from behind to before, is found a groove for lodging the internal carotid artery, after it has emerged from the canal, and the cavernous sinus: this groove is continued upwards underneath the anterior clinoid processes, and is sometimes converted into a complete foramen for the passage of the vessel. Extending laterally from the body of the bone, are the internal surfaces of the alæ majores, hollowed out into numerous concavities to correspond to the convolutions of the brain, and grooved by the arteries of the dura mater: they project backwards in a triangular form to terminate in the spinous process of the bone, which has been described on the external surface, and which is admitted into the space between the squamous and petrous portions of the temporal bone. The alæ majores present upon their upper and anterior parts, a rough and somewhat triangular surface, for their attachment with the frontal and parietal bones: their outer semilunar serrated concavities, which receive the temporal bones, are as obvious upon this as the external surface of the bone.

The last processes to be described are the *alæ minores*, or *processus ingrassias*, which arise broad from the anterior part of the body of the bone, and extending transversely outwards, terminate in slender pointed extremities, which are sometimes attached to the greater wings, and complete the foramina lacera orbitalia superiora: while, at other times, these two portions of bone are not connected, and the foramina are, in that case, completed by the junction of the frontal bone with the sphenoid. These slender pointed portions of the alæ minores are termed the *transverse spinous processes:* their posterior edge is smooth, and gives attachment to a process of the dura mater, which separates the anterior from the middle lobes of the brain: their anterior edge is rough, to be joined to the orbitar process of the frontal bone; and in the middle part, the alæ minores are connected by a thin plate of bone, which, posteriorly, is joined to the body of the sphenoid bone, and, anteriorly, to the ethmoid. This plate, or portion, may be called the *ethmoidal spine*. The superior surface of these alæ support the anterior lobes of the brain: their under surface forms a small part of the roof of the orbit posteriorly, and the foramina lacera orbitalia superiora, to which we have already adverted.

The foramina in this bone are numerous, and consist of pairs: six pairs are *proper* to the bone, and four are *common* to it and other bones.

The six proper are, first, the *foramina optica*, which are situated at the junction of the roots of the alæ minores with the body of the sphenoid bone: they are directed forwards, outwards, and rather downwards into the orbit, and are for the passage of the optic nerves, and opthalmic branches of the internal carotid arteries. Behind, and to the outer side of these are situated the *foramina lacera orbitalia superiora*, which are directed from within to without, and from below upwards. They are formed by the junction of the alæ majores and minores to the body of the bone on the inner side of the foramen, and to each other on the outer: more frequently, however, assisted, as has been before observed, by the frontal bone. These foramina communicate with the orbits, and allow of the transmission of the third, fourth, first division of the fifth, and sixth pair of cerebral nerves—all of which pass to supply the eye and its appendages: they also admit the opthalmic veins to pass through them backwards from the orbit to terminate in the cavernous sinuses, which are situated immediately posterior to them. Directly under these foramina, and slightly posterior to them, are placed the *foramina rotunda*, which pass somewhat downward, and lead to the spheno-maxillary fossæ: they transmit the second division or superior maxillary branch of the fifth pair of nerves. Nearly an inch behind these, and external to them, are placed the *foramina ovalia*, for the passage of the third division of the fifth pair, or the inferior maxillary nerve: the names of these two last mentioned nerves indicate their distribution. Behind the foramina ovalia, and to their outer side, are found the *foramina spinosa*, which are small, and are named from their situation. They give passage to the middle artery of the dura mater, a branch from the internal maxillary of the external carotid artery. All these foramina pierce the bone, and therefore might be described as well on the external as on the internal surface: but there are two foramina *proper* to the external surface—the *foramina ptery-*

goidea—commencing before, from the spheno-maxillary fossa, and terminating posteriorly at the foramina lacera basis cranii anteriora. They transmit a branch of the second division of the fifth pair, which divides into two at the posterior opening at these foramina: one branch goes upwards into the skull through the foramina lacera basis cranii anteriora, and the other downwards into the carotid canal; and both of these openings are close to the foramina pterygoidea. I have mentioned these nerves only for the purpose of pointing out the exact position of the foramina. There are also to be observed openings of the sphenoidal sinuses, anterior to the processus azygos, on the external surface of the body of the sphenoid bone.

The foramina *common* to the sphenoid and other bones, are the *foramina lacera basis cranii anteriora*, formed by the junction of the body of the sphenoid with the extremity of the petrous portions of the temporal bones; through which pass, as before described, a reflected branch of the second division of the fifth pair of nevers, and a small artery of the dura mater. The *foramina spheno-palatina* are produced by the junction of the roots of the pterygoid processes of the sphenoid with the neck of the nasal plate of the palate bones, immediately below their orbitar processes: they transmit the lateral nasal branch of the second division of the fifth pair of nerves into the nose, leading from the spheno-maxillary fossa, and also an accompanying branch of the internal maxillary artery.

The *foramina pterygo-palatina*, which run sufficiently far, rather to deserve the name of canals, proceed downwards from the spheno-maxillary fossa. They are formed at first by the two bones from which they have acquired their name, and afterwards by the maxillary and palate bones, and terminate in the upper and back part of the roof of the mouth in the *palato-maxillary foramen*. These foramina transmit the descending palatine, or palato-maxillary nerve of the second division of the fifth pair, and its corresponding artery, from the internal maxillary.

Lastly, the *spheno-maxillary fissures*, or *foramina lacera orbitalia inferiora*, are situated between the orbitar processes of the sphenoid and superior maxillary bones, and are bounded behind by the palate bones: they extend along the back and under part of the orbits, communicate with the spheno-maxillary fossa, and allow the passage of the infra-orbitar nerve, and a branch of the internal maxillary artery. It may also be observed, that the carotid canal is in part common to the sphenoid and temporal bones.

Connexion.—In the description of the attachment of this bone to the other bones of the skull, it is to be considered as placed in its natural position, and beginning from before on the middle line, passing outwards, then backwards, and lastly to its inferior surface. The os sphenoides is connected by the rough edge of the anterior and middle part of the body, which is termed the ethmoidal spine, with the ethmoid bone; by the alæ minores, and anterior edge of the alæ majores with the frontal bone; and by the rough triangular surface on the external and superior edge of the alæ majores with the parietal bones. The ridge on the fore part of the alæ majores, separating the orbitar from the temporal processes, and termed the malar process, connects the sphenoid with the malar bone; by the whole of the outer serrated edges of the alæ majores, extending as far backwards as to the spinous processes, it is joined to the squamous and petrous portions of the temporal bones; and lastly by the posterior part of its body to the occipital bone it is joined by epiphysis in early periods of life. The anterior surfaces of the pterygoid processes are attached to the palate bone; and sometimes also immediately below this attachment these processes are connected to the superior maxillary bone: lastly, the azygos process of the sphenoid bone is joined to the vomer.

Attachment of Muscles.—The following muscles are attached to the os sphenoides, all of them having their origin from it, viz :—*all* the muscles of the eye, excepting the inferior oblique:—m. levatores palpabrarum superiorum, levatores, depressores, abductores, adductores et obliqui superiores oculorum, temporales, pterygoidei externi and interni, buccinatores, externi mallei, constrictor pharyngis superior, and tensores palati.

Use.—The use of this bone, in common with the other bones which assist in forming the cranium, is to support the brain; but it also particularly serves to strengthen the skull by the manner in which it extends across the base and is clamped with the temporal bones, preventing the separation of these bones from a blow on the vertex. Through its numerous foramina it allows of the passage of important nerves from the brain. It also assists in forming the bony orbit, the nose, and the upper and lateral boundary of the pharynx. The sphenoid bone in the quadrumina is frequently divided into two parts, one of them forms the alæ minores and anterior clinoid processes, and the other parts are included in the posterior portion.

Practical Points.

This bone cannot be fractured from the immediate application of any external violence upon it, being so deeply seated; but it is liable to fracture from blows upon the vertex of the skull; which accident is indicated by bleeding from the ears, and sometimes from the nose, in consequence of the rupture of some of the vessels of the mucous membrane lining the sphenoidal sinuses, which open into the nose. It is, also, liable to be affected by diseases incident to the mucous membrane, as polypi, etc.

The Os Ethmoides.

(ηϕμοσ a sieve ειδοσ likeness.)

Is placed in the anterior, inferior, and middle line of the base of the skull, between the two orbitar plates of the frontal bone.

It is of a cuboidal figure, cellular in its structure, and has derived its name from being penetrated by numerous holes for the transmission of the first pair of nerves. It presents the following parts for description, viz.: its *horizontal plate*, its *ascending*, *descending*, and *lateral laminæ*, its *cells* and *turbinated bones.*

The *horizontal plate,* which forms the body of the bone, is cribriform, has its long axis from before to behind, and offers a superior and an inferior surface, an anterior, posterior, and two lateral edges. From the superior surface, situated anteriorly, there ascends a triangular lamina of bone, named the *crista galli*, which is compact in its structure, and terminates in a point or apex: its base is attached to the horizontal plate of the bone, while the apex gives attachment to the falx major. The fore part of the crista, which is vertical, is grooved, and by its junction at this point with the frontal bone usually completes the foramen cœcum. From the under surface of the cribriform or horizontal plate, there passes downwards the *nasal lamella*, having a base in common with the crista galli: it usually does not pass downwards vertically into the nose, but with an obliquity, so as to divide that cavity unequally. This nasal lamella is not of so compact a structure as the crista galli; but its edges are thicker than the rest of the bone, for its attachment with other bones and cartilages of the nose. The lateral edges of the cribriform plate give attachment to numerous cells of an unequal size, which open into each other and into the cavity of the nose: they are termed the *ethmoidal cells*, and are divided into the anterior and posterior. The anterior are covered by the ossa unguis, and the posterior by thin laminæ which form a part of the bony orbit; from which circumstance they are named the *orbitar processes.* On the upper edges of these processes two notches may be observed, which serve for the completion of the two internal orbitar foramina by their junction with the frontal bone: their circumference is rough for their attachment to other bones forming the orbit. Below, and to the inner side of the orbitar plates, are found two thin processes of bone, being irregular in their form, but twisted upon themselves so as to produce a convex internal surface towards the nasal lamella, and a concave outer one enlarging the cavity of the nose: the upper edge only is attached to the ethmoid bone, the lower hanging pendulous into the nose. These two bones are termed the *ossa turbinata* or *spongiosa,* but are to be considered as processes of the ethmoid bone. All those parts of the ethmoid bone communicating with the cavity of the nose, including the cells, are covered by a continuation of the pituitary membrane.

Connexion.—Within the orbits, the ethmoid bone is connected by the upper edge of its orbitar plate with the frontal bone, anteriorly with the lachrymal, and below with the superior maxillary and palate bones; the posterior edge of its horizontal plate connects it with the sphenoid, and within the nose it is united below with the vomer and in front with the nasal bones.

Use.—The ethmoid bone serves the purpose of supporting the anterior lobes of the brain, and of protecting and transmitting the first pair of olfactory nerves; it assists also in forming the orbit, the bony cavity, and septum of the nose, and enlarges the surface for the attachment of the pituitary membrane.

The degree of acuteness of smell, of any animal, may be estimated by the developement of this bone as to the size of its cribriform plate and the complexity of its turbinated bones, which are all fully developed in the feræ and pecora but narrow in the quadrumina. The cetacea have no ethmoid bone, and the first division of the fifth pair of nerves seems to perform their function of smell.

This bone has no muscles connected with it.

Practical Points.

The ethmoid bone is particularly liable to exfoliation from its peculiar texture, and is frequently involved in the diseases incident to the lining membrane of the nose: hence, in ozena and syphilis, the destruction of parts of this bone often follows. Polypi being usually fixed to the superior turbinated bones, a knowledge of their delicate structure should render the surgeon particularly careful in their extraction. Severe and extensive fracture of the ossa nasi does not offer so favourable a prognosis as might be supposed, when we consider the injury the ethmoid bone is liable to sustain, and its proximity to the brain. Malignant tumours, situated within the ethmoidal cells, will equally affect the eye and nose.

The bones which I have described are proper to the cranium, the interior dimensions of which may be taken in the following manner. The antero-posterior diameter extends from the foramen cœcum to the internal occipital protuberance, and is generally about five inches in length. Its transverse diameter is to be measured from the attachment of the base of the petrous portions of the temporal bones with the squamous, and which is usually four inches and a half, but the width diminishes both before and behind this junction. Its vertical diameter is measured from the anterior part of the occipital foramen to the centre of the sagittal suture, which is usually rather less than the lateral dimension. The interior of the skull is divided into its vault and base. The vault presents the coronal suture, the cerebral surface of the frontal bone, with its spine and groove for the longitudinal sinus, the sigittal suture, the cerebral surface of the parietal bones, the lambdoidal suture, a continuation of the sulcus for the longitudinal sinus, and the depressions on the occipital bone for the posterior lobes of the cerebrum.

The Bones of the Face

Form the under and fore part of the head, comprising all that portion below the os frontis, and anterior to the pterygoid processes of the sphenoid bone. In conjunction, also, they form the upper and lower jaws—the former being immoveably fixed to the cranium, while the latter, forming the principal organ of mastication, is attached by a moveable articulation to the temporal bones.

Although the whole of that part of the face, above the inferior maxillary, bone may be considered as constituting the upper jaw, still we shall find it composed of numerous separable bones, named from the different parts which they assist in forming: but, as a whole, they are so firmly connected as to be individually incapable of exercising any independant motion.

The two organs which principally constitute the size of the face are those of smell and taste, and in proportion, therefore, as they are developed in different animals does the face bear a larger size in comparison to the cranium.

The bones of the face consist of the *ossa nasi*, *ossa unguis* or *lachrymalia*, *ossa malarum*, *ossa maxillaria superiora*, *ossa palati*, *ossa spongiosa inferiora*, and *os vomer*. These are the bones which constitute the upper jaw, which at the adult period of life is furnished with sixteen teeth; while the lower jaw consists of a single bone, the *os maxillare inferius*, with a like number of teeth.

I shall now proceed to describe each of these bones separately.

The Ossa Nasi,

(Nasus, the nose.)

Are situated immediately under the nasal processes of the os frontis, from which they project downwards and forwards, forming the dorsum of the nose: they are each of an oblong form, having their long axis from above to below, and present two surfaces, and four edges. Their surfaces are an *external* convex one, to give strength and form to the nose; an *internal* concave one, to enlarge the cavity. Their *superior edges* are rough, thick and compact, producing a very firm connexion with the nasal process of the frontal bone; and forming, by this union, a part of the transverse suture. The *anterior edges* are each slightly roughened for attachment with its fellow. The *posterior edges* are peculiar, being hollowed above to *receive* the nasal process of the superior maxillary bone, and thin below, where they *overlap* the superior maxillary: thus giving great strength to the articulation. These bones become wider as they descend towards their *inferior* *edges;* which are spreading, and very irregular, to give attachment to the cartilages of the nose. The two ossa nasi, when connected, form an arch, filling up the space between the nasal processes of the superior maxillary bones; thus constituting the four part of the nasal cavity. From their junction internally proceeds *a nasal spine,* through the medium of which they become connected with the ethmoid bone.

There is considerable variety in the form of the nasal bones in different animals, in most quadrupeds however there are two, but in the elephant only rudiments, and in the quadrumana only a single bone.

Connexion.—These bones are connected, above, to the os frontis; anteriorly, to each other, and to the nasal plate of the ethmoid; posteriorly, to the superior maxillary bones; and internally, to the septum narium.

Attachment of Muscles.—Those attached to the nasal bones are the occipito-frontalis, and compressor naris.

Practical Remarks.

The manner in which these bones are articulated, as well as their arched form, render them but little liable to fracture, notwithstanding their exposed position, and the little protection afforded them by soft parts. When, however, they are broken, the diagnosis is sufficiently obvious from the deformity produced. The prognosis is favourable, unless the accident be complicated with injury to some more important parts. Compound fractures are usually followed by exfoliation of bone, rendering the cure tedious.

The best mode of replacing the fractured bones of the nose is by introducing the blades of common dressing forceps into the nostrils; and if there be any difficulty in retaining the fractured portions in their natural position, a piece of air elastic gum catheter, surrounded with lint, should be introduced to give support to the parts, and at the same time the tube will allow of respiration going on through the nose.

The Ossa Lachrymalia,

(Lachryma, a tear.)

Or, *ossa unguis,* have been so named from their use and form: they are situated on the inner and fore part of the orbit, and present an *external* and *internal surface,* and *four edges.* The *external surface* is divided by a thin ridge into two portions; the posterior of which is plain, forming a part of the orbit, and may be called therefore the *orbitar process.* The anterior portion is hollowed, and assists in forming a cavity for lodging the lachrymal sac, and ductus ad nasum. The internal surface is irregular, and covers the anterior ethmoidal cells.

Connexion.—The *superior edge* connects them with the os frontis, forming a part of the transverse suture; the *posterior* *edge* with the orbitar process of the ethmoid bone; the *anterior edge* with the nasal process of the superior maxillary; and the *inferior edge* with the orbitar process of the same bone. Within the nose these bones are slightly connected to the inferior turbinated bone; forming there, with the assistance of the superior maxillary bone, the ductus ad nasum.

The lachrymal bones are found in most mammalia, but are wanting in the elephant; they are particularly large in the antelope, and seem to form breathing holes.

There are not any *muscles* attached to them.

Practical Points.

The texture as well as the situation of this bone is important to the surgeon, especially in reference to fistula lachrymalis. In this disease, the delicate structure of the bone suggests the propriety of an early opening, to evacuate the matter; and requires caution, in the performance of the operation for its radical cure.

The use of this bone is sufficiently implied by its description.

The Ossa Malarum,

(Malus, an apple.)

Are the square prominent bones which form the cheeks: their external surface is convex and smooth—their internal surface is concave. These bones, anteriorly, form the cheeks; posteriorly, they join the temporal bones; and, superiorly, enter into the composition of the orbit.

The form of these bones is an irregular square, and they may be divided into three distinct parts or surfaces, which will point out both their position and use. They present a superior or orbital surface, an external or facial surface, and a posterior or temporal surface; but each of these parts is subdivided by processes which are to be described.

The superior or orbital portion of the bone is semilunar in its form, and terminates by two cornua: the superior one is rough, to be connected with the frontal bone, just at the outer and superior part of the orbit, and is termed the *superior orbitar process:* the inferior cornu is also roughened, to form a similar junction with the superior maxillary bone, and is termed the *inferior orbitar process;* by this union forming the anterior boundary of the spheno-maxillary fissure. The concave line, running from the one cornu to the other, forms the external brim to the orbit; from which passes backwards a triangular concave process of bone, forming a part of the orbit, and denominated the *internal orbitar process:* this is connected above with the orbitar process of the frontal bone, and below with the sphenoid.

The *external* or *facial surface* of the bone is convex and smooth, forming an anterior right angle, and a posterior acute one. The anterior angle is rough, for its connexion with the malar process of the superior maxillary bone; while the posterior one forms the *zygomatic process*, and connects it with the temporal bone: completing, by their junction, the zygomatic arch. The inferior edge of the facial surface is straight, and slightly rough, for the attachment of the masseter muscle.

The *posterior* or *temporal surface* is concave, and smooth above, for the passage of the temporal muscle; and somewhat rough below, for the origin of the masseter.

There is only one complete foramen in this bone, called the malar: it passes from the orbital through to the facial surface, and transmits a branch of the second division of the fifth pair of nerves, together with a branch of the internal maxillary artery. This bone likewise forms the anterior extremity of the spheno-maxillary fissure.

Connexion.—The malar bone is connected, by its superior orbitar process, to the frontal bone, forming a part of the transverse suture; by its internal orbitar process, to the sphenoid bone; by its inferior orbitar process, and anterior angle, to the superior maxillary bone; and by its posterior acute angle, to the temporal bone.

The size of the zygomatic arch, produced by the junction of the malar and temporal bones, differs in different animals; in the carnivora it is largest, both in its horizontal and vertical dimensions, corresponding with the size of the muscles of mastication.

The Attachment of Muscles to the malar bones are the zygomatici and masseter: the orbicularis palpebrarum in front, and the temporal muscle behind, cover portions of these bones without being connected to them.

Practical Remarks.

From the exposed situation of these bones they are liable to fracture, although from their arched form the force to produce the accident is necessarily so considerable, as usually to effect comminution of bone, and laceration of the soft parts, rendering the fracture compound. In this case, the surgeon should carefully remove all the detached portions of bone, and any extraneous body, which may have been introduced; as deep fistulous abscesses are liable to form in the cavities behind these bones. Inflammation of the eye, frequently follows these accidents, from the fracture extending into the orbit. It is behind the zygomatic arch, formed by this bone and the temporal, that the condyloid process of the lower jaw is thrown in dislocation.

The Ossa Maxillaria Superiora.

(*μασσαω*, to chew.)

Of the six pairs of bones which enter into the composition of the upper jaw these are the largest, and derive, on that account, their specific name. The form of these bones is extremely irregular, offering a number of processes and depressions, which enter into the composition of the cavities of the orbits, nose and mouth.

Each maxillary bone is divided into a body and seven processes.

The *body* occupies the central portion of the bone, and is hollowed out, forming the *antrum highmorianum*, which has a natural opening into the middle chamber of the nose, and is lined by a continuation of the pituitary membrane. The anterior and external surface of the body presents a *concavity,* which is situated immediately beneath the foramen infra orbitale, giving origin to the m. levator anguli oris. The posterior extremity of the body is rounded, and forms the *tuberosity* of this bone, which is rough for the attachment of the pterygoid process of the palate bone, and origin of the m. pterygoideus externus. On the inner side of the tuberosity is a *groove,* forming part of the *palato-maxillary foramen,* which is completed by the palate bone, it leads from the spheno-palatine *canal* into the roof of the mouth, and transmits the palatine nerve and artery. The lower part of the body forms an irregularly curved line, divided into compartments for the insertion of eight teeth, which portion of the bone, is called the *alveolar process.* The upper part of the body presents a plain somewhat concave surface, which forms the lower part of the orbit; and is called the *orbitar process;* upon this process may be observed, posteriorly, a groove which soon becomes a canal, and terminates as the *infra-orbitar foramen* upon the body of the bone, through which passes a branch of the second division of the fifth pair of nerves. The form of the orbitar process is triangular, its inner edge being rough for its attachment to the lachrymal, ethmoid, and palate bones within the orbit, while its outer margin forms a part of the *spheno-maxillary fissure*, or *foramen lacerum orbitale inferius.* Anteriorly, and on the inner side of the orbitar process, a portion of bone passes upwards to be connected with the os frontis; and forming the lateral parts of the nose, is called the *nasal process.* It presents a base, attaching it to the body of the maxillary bone; an apex, roughened, to connect it with the frontal bone; an external convex surface, and an internal surface, concave, to enlarge the nasal cavity. Upon this cavity we observe a *ridge* of bone, running from before to behind, to lodge the inferior turbinated bone; an anterior thin edge, to connect it with the nasal bones; and a posterior edge, forming a deep *sulcus*, completed into the *ductus ad nasum* by the lachrymal and inferior turbinated bones. Upon the outer side of the orbitar process is seen a rough triangular projection, termed the *malar process*, from its giving connexion to that bone. Immediately behind this process is seen a depression, for the passage of the temporal muscle. Projecting horizontally inwards, from the body of the bone, is the *palatine process*. It is concave both above and below, to enlarge the cavities of the nose and mouth; rough behind, for its attachment to the palate bone, and rough on its inner edge, to join with its fellow. By this junction a projecting *spine* is formed into the nose, called the *nasal spine*, and which extends sufficiently forwards to produce the internal boundary of a sulcus, between it and the root of the nasal process. This sulcus, in the skeleton, forms the anterior opening to the nares. On the anterior part of the rough surface, which connects the palatine process with its fellow, is found a groove running in a vertical direction on each bone, which form, by their junction, a canal, common to the two bones below, but terminating, above, in a foramen proper to each maxillary bone. This canal is called the *ductus incisivus:* establishing a communication between the nostrils and the mouth.

The foramina proper to this bone, are:—the *foramen infra-orbitale*, forming the anterior opening of the infra-orbitar canal: and the *foramen incisivum*, passing from the nose, and joining with its fellow, to form the ductus incisivus. The common foramina are, the *palato-maxillary*, the *spheno-maxillary fissure*, and the *ductus incisivus*. The names of the two former express their construction; the latter is formed by the junction of the palatine processes of the two bones. The maxillary, with the assistance of the lachrymal and inferior turbinated bones, form the fossa for lodging the lachrymal sac and the ductus ad nasum.

Connexion.—The superior maxillary bone is connected, by its malar process and orbitar process, to the malar bone; by the anterior edge of the nasal process, to the nasal bone; by its upper extremity, to the os frontis; by the posterior edge of the same process, and by the adjoining part of the orbitar plate, to the lachrymal bone, behind which the orbitar plate joins the ethmoid. The back part of the orbitar process, together with the tuberosity and the posterior edge of the palatine process, is connected to the palatine bone. The internal edge of the palatine process joins its fellow; the inferior turbinated bone is attached to the ridge running across the internal surface of the nasal process: and lastly; the vomer is connected to the nasal spine, produced by the union of the two ossa maxillaria.

In many animals the superior mixillary bones do not unite below the nose, nor contain all the upper teeth; but there are two bones interposed which are termed the ossa inter-maxillaria.

Attachment of Muscles.—The muscles attached to each superior maxillary bone are the masseter, the constricter pharyngis superior, the pterygoideus externus, the buccinator, the levator anguli oris, the levator et depressor labii superioris, alæque nasi, the orbicularis palpebrarum, the obliquus oculi inferior, and compressor naris.

This bone forms the greatest part of the floor and lateral walls of the nose. It also forms the whole of the antrum highmorianum communicating with the nasal cavity, and enters into the composition of the orbit and the lachrymal apparatus. It forms the larger portion of the bony palate, and, by receiving the upper teeth, becomes essentially a part of the organ of mastication.

The Practical Points

Connected with the superior maxillary bones are numerous in proportion to the many offices these bones assist in performing, but more particularly as connected with the diseases of the mucous membrane lining the antrum highmorianum: which cavity being in such close connexion with the eye, forming its upper boundary, the nose having an opening into it on the inner side, and the mouth below, each of these parts become soon secondarily affected; therefore, in cases of suppuration, the matter should be very early evacuated. This is effected by extracting the last molar tooth but one, the fang of which usually penetrates the cavity; or, should it not do so, a pointed instrument should be pushed into it, and the pus let out. The opening should be made sufficiently large, to admit readily of the cavity being injected; and if the drawing of one tooth be not sufficient to effect this, two or even more should be extracted. Polypi frequently form in the antrum; and in aggravated cases the form of the face is sometimes most hideously altered, and the function of the neighbouring organs destroyed. This happens when the polypus is of a malignant character; therefore as soon as the surgeon ascertains such a tendency, a trephine should be applied on the body of the maxillary bone, and the disease removed. It should be held in mind that diseased teeth are frequently the exciting cause of diseased antrum, and that the removal of a tooth at an early period frequently prevents all the baneful effects described.

The Ossa Palati,

(Palo, to hedge in.)

Are situated in the roof of the mouth, immediately behind the palatine processes of the superior maxillary bones, and they together form the bony palate: they also extend, so as to produce a part of the cavity of the nose and orbit. They are extremely irregular in their form, but are divided into four distinct parts:—their *body* or *palatine process*, their *nasal process*, their *orbitar process*, and lastly, their *pterygoid process:* each part by its name implying its use and its situation.

The *body*, or *palatine process*, is the most compact part of the bone. It forms an horizontal square plate, which presents a *superior* surface, concave, to enlarge the cavity of the nose; an *inferior* concave surface, to form the posterior part of the roof of the mouth; an *anterior* serrated edge, which connects this part of the palate bone to the superior maxillary bone; a *posterior*, smooth, semilunar edge, which gives attachment to the muscles of the soft palate; an *inner* straight edge, elevated and rough, to be connected with its fellow; their junction forming the *nasal spine* and part of the bony septum of the nose: and lastly, an *external* edge, which connects this portion of the palate bone to its

Nasal or ascending process.—This process is a thin lamina of bone, rising perpendicularly upward from the outer edge of the palatine process, and passing into the nose on the inner side of the tuberosity of the superior maxillary bone. The nasal plate presents an internal surface, which forms the outer bony boundary to the nose, and has placed upon it a thin *spine* passing from before to behind, which lodges the inferior turbinated bone. Its *external* surface is rough, to attach it to the maxillary bone, and presents a deep groove passing from above to below, leading into the roof of the mouth, and forming the *palato-maxillary foramen*. The upper half of the nasal process covers the posterior part of the antrum highmorianum, and diminishes the opening of this cavity into the middle chamber of the nose. From the anterior upper edge of the nasal plate, the third process of the palate bone presents itself, viz., the *orbitar process*. This is attached to the nasal lamella by a kind of neck, giving the appearance of a notch when the palate bone is separated from the other bones of the head, but forming, by its junction with the sphenoid bone, a foramen, which leads into the nose, and is termed the *spheno-palatine or lateral nasal foramen*. The *orbitar process* is of a triangular shape, being wedged in at the back part of the orbit, between the orbitar processes of the superior maxillary ethmoid and sphenoid bones. The posterior surface of this process of the palate bone is hollow and cellular, covering, and, indeed, enlarging the posterior ethmoidal cells.

The last process to be described is the *pterygoid process*, which passes outwards, backwards, and slightly downwards, from the posterior point of attachment of the horizontal palatine with the ascending nasal process. It is of a triangular form, and the apex of the triangle is admitted between the anterior part of the pterygoid processes of the sphenoid and the tuberosity of the maxillary bones. The posterior surface of this process produces two grooves, which are occupied by corresponding eminences on the anterior part of the pterygoid processes.

This bone has no *proper* foramina, but the two which are common to it, and to the sphenoid and maxillary bones, have been already described; namely, the palato-maxillary, and spheno-palatine foramina.

Connexion.—The palate bone is connected within the orbit, with the ethmoid and superior maxillary bones, and in the nose with its fellow, the vomer, the sphenoid, and inferior turbinated bone.

The *Muscles* attached to the ossa palati, are the m. pterygoidei externi and interni, buccinatores, constrictor pharyngis superior, circumflexus palati, and azygos uvulæ.

Use.—Assists in forming the mouth, nose and orbit, and it also completes the posterior ethmoidal cells.

Practical Remarks.

The palatine plates of these bones, as well as the superior maxillary bones, are sometimes unnaturally separated from each other in malformation. They are liable to exfoliation from syphilitic affections of the soft palate; and their delicate structure should also be remembered in the removal of polypi.

The Os Vomer,

(Vomo, to cast up.)

Is an irregular square bone, situated in the median line of the face, and forms the principal part of the bony septum of the nose. It presents *four edges,* taking an oblique direction from behind to before, and two surfaces.

The *superior* edge, the thickest, forms a deep groove to receive the azygos process of the sphenoid bone, offering the best example of articulation by schindylesis: the *inferior* edge is thinner and longer, and is connected to the nasal spines of the superior maxillary and palate bones. Its *anterior* edge forms a deep sulcus, to be joined to the posterior edge of the nasal lamella of the ethmoid bone, and anteriorly with the cartilage, completing the septum of the nose. The *posterior* edge is somewhat rounded, turned towards the pharynx, and separates the posterior openings of the two nasal cavities. The surfaces of this bone form the inner boundary of each nostril.

Connexion.—This bone is connected above, with the sphenoid; below, with the superior maxillary and palate bones; and, before, with the ethmoid. Its posterior edge divides the bony cavity of the nose; and thus forms a septum to the nares, as they open into the pharynx.

The Vomer sometimes has an opening through from one nostril to the other.

The Ossa Turbinata Inferiora.

(Turbino, to sharpen.)

These bones offer a very considerable addition to the cavity of the nose, by affording a greater extent of surface for the attachment of the pituitary membrane, without increasing the size of that organ. They are very similar in shape to the superior turbinated bones, and have their convexities turned inwards. From the superior edge extend two *processes;* the *anterior* or *processus lachrymalis,* passes upwards to the lachrymal plate of the os unguis, and completes the ductus ad nasum. The *posterior process* is larger, becomes curved downwards, and is attached to the lower edge of the opening of the maxillary antrum, which it thus partly closes. The bone becomes narrower towards each extremity, but terminates in a much more acute point behind than before. The turbinated bone is connected by its superior edge only: the anterior part of which is attached to the ridge on the inner surface of the nasal process of the superior maxillary bone, and to the unguis: the posterior part is fixed to a similar ridge on the nasal plate of the palate bone. The rest of the bone is unattached, and projects into the nasal cavity.

Connexion.—Each turbinated bone is connected with the superior maxillary and palate bones, and also with the os lachrymale.

The *use* of this bone is, to form an extended surface for the attachment of the lining membrane of the nose, and to assist in closing the entrance of the antrum highmorianum. It also assists in forming the ductus ad nasum, and divides the middle from the inferior chambers of the nose.

Practical Remarks.

The principal pathological facts connected with this bone refer to its texture, which is so delicate, that in disease it readily exfoliates. In the removal, also, of polypi, or any extraneous bodies from the nasal cavities, it requires great caution not to injure it. In fistula lachrymalis, as a palliative remedy, a small probe is sometimes passed up the ductus ad nasum, which opens immediately behind this bone into the lower chamber of the nose: its situation, therefore, should be carefully examined.

The Os Maxillare Inferius,

(μασσαω to chew.)

Is a single moveable bone, situated immediately below the upper jaw, and forms the lower boundary to the face. It is somewhat of the figure of a horse's shoe, or the Greek letter *υ;* to facilitate its description, it may be divided into its *body,* or chin; its *horizontal plate;* and its *ascending ramus,* terminating in the *condyloid,* and *coronoid processes.* Both the external and internal surface of this bone offer many lines and irregularities, for the attachment of the numerous muscles necessary to the various functions which this bone has to perform in mastication, speech, deglutition, etc. etc.

The *body* of the bone, or *chin*, forms the most anterior and central part of the bone; on its external convex surface, it is bounded on either side by the anterior maxillary, or mental foramen; and by the termination of two oblique lines, on its internal concave surface. The middle line, joining the two symmetrical sides of the jaw-bone, is termed the *symphisis*, which, at the lower part, is formed into a rounded protuberance, to which the term *chin* is more especially applied; from the symphisis a short line extends laterally outwards and upwards on each side, giving attachment to the muscles which depress the lower lip. The muscles which raise the lip also mark this portion of the bone, at the root of the sockets of the two outer dentes incisivi. The internal surface of the symphisis of the lower jaw, in the middle line, is marked by a process of bone, which is termed the *spine*. It is sometimes bifid; and, at others, divided into three or more small projections. They give attachment to the frænum of the tongue, above; to the m. genio-hyoglossi, in the middle; and the genio-hyoidei, below: and on each side, a small rough depression marks the attachment of the m. digastrici. The upper portion of the body of the bone forms a part of the *alveolar process*, which contains the sockets for eight teeth. This process, however, extends backwards, along the horizontal plate of the jaw, as far as to the root of the coronoid process.

The *horizontal plate* of the lower jaw is that surface bounded before by the anterior maxillary foramen and body of the bone, and behind by what is called the *angle* of the lower jaw: an angle formed by the junction of the horizontal with the ascending plate of the same bone. The external surface of this horizontal plate presents a *ridge*, commencing from its base, and, running obliquely upwards and backwards, ascends a considerable way above the level of the plate. It terminates in a peak, which forms the anterior boundary of what is called the coronoid process. This oblique ridge may be said to divide, unequally, the external surface of the horizontal plate into an anterior and posterior portion. In describing the former, we distinguish the upper edge, which constitutes a part of the alveolar process. In the latter, we notice its base, proceeding backwards to form, by its junction with the ascending plate, the angle: while passing forwards, continuously with the lower edge of the anterior portion of the horizontal plate and body of the jaw, it completes the proper *base* of the bone. The internal surface of the horizontal plate has a very close resemblance to the external one; being, like it, divided into an anterior and posterior portion by a similar oblique ridge, but which proceeds to the posterior maxillary foramen instead of to the coronoid process, as the external ridge does. This ridge gives origin to the m. mylo-hyoideus.

The *ascending plate* divides itself into two processes superiorly, and presents a semilunar edge between the two, which has its concavity turned upwards: inferiorly, it is bounded by the horizontal plate and angle of the jaw: posteriorly, it forms an obtuse edge, which passes upwards, and terminates by producing the neck and condyloid process. The anterior edge is sharp, and forms the coronoid process: it presents an external surface, roughened for the attachment of the masseter muscle; and an internal one, which gives insertion to the pterygoideus internus.

The *coronoid process* extends perpendicularly upwards, becoming pointed towards its extremity, which, when the jaws are closed, is received behind the zygomatic arch. Its posterior edge is thin, its anterior rather more rounded, and it is flattened laterally. This process is completely surrounded by the insertion of the temporal muscle, which also extends along its anterior edge as far as the horizontal plate of the bone.

The *condyloid process* passes upwards and a little backwards, and is attached to the ascending plate by a contracted portion of bone, called the *cervix;* on the inner side of which there is a *depression*, for the insertion of the pterygoideus externus muscle. The condyle itself or extremity of the process, is convex and of an oval shape, having its greatest length from side to side. It is, also, more covered anteriorly with cartilage than posteriorly, so as to be capable of motion upon the articulatory surface, at the root of the zygomatic process of the temporal bone. It is received into the fossa condyloidea, or anterior depression of the glenoid cavity in the temporal bone, to which it is connected by a moveable articulation.

The foramina of this bone consist of two pairs, viz.:—the posterior and anterior maxillary.

The *posterior maxillary foramina* are situated on the inner surface of the ascending plates, and allow the entrance of the dental nerves and arteries. They are protected by a projecting process of bone, which gives attachment to the internal temporo-maxillary ligament.

The *anterior maxillary* or *mental foramina*, are situated on the external surface of the bone, at the junction of the body with the horizontal plates: they allow the exit of the same

Plate I.

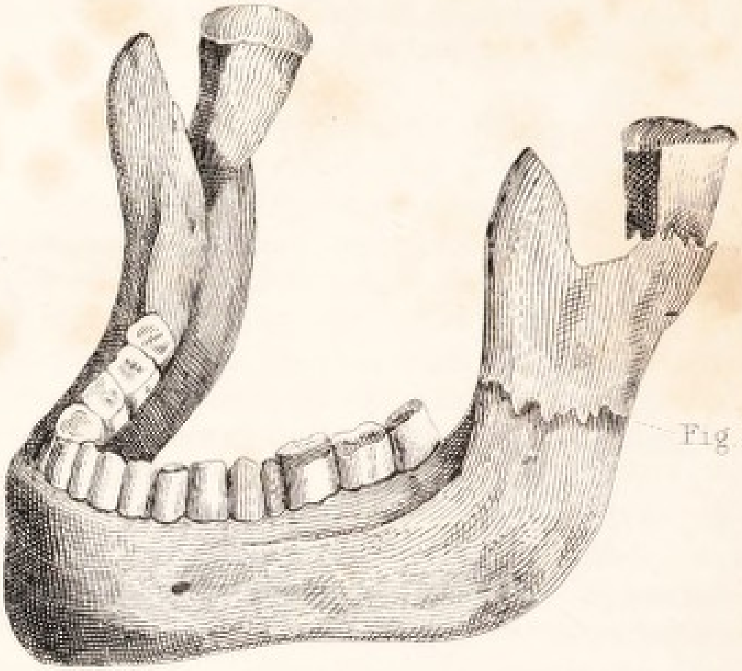


Fig 1.

Fig 2.

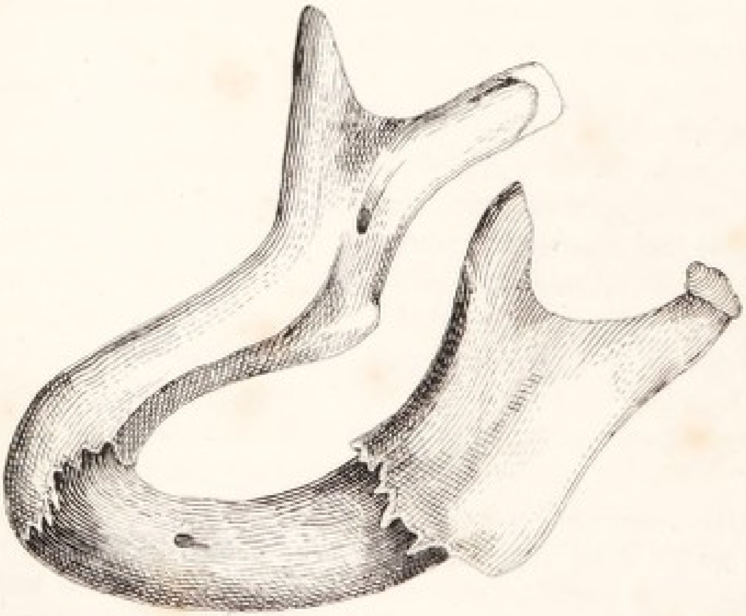


Fig 3.

Tarr lith.

nerves and blood-vessels mentioned above. These foramina are connected on each side by an intervening canal, which also extends as far as the symphisis. Small openings are found, leading from it to the sockets of the teeth. This canal is termed the *canalis mentalis.*

The only bones with which the lower jaw is connected are the temporal on each side, as already described.

The lower jaw of man differs perhaps more than any other bone from that of the lower animals, and the difference principally consists in the prominence of the chin, which forms a very peculiar characteristic of the human countenance. The formation of the condyles also offers very strong distinguishing marks in the jaws of different animals, permitting of rotatory motion in some, and only the hinge like movements in others, indicating the kind of food which the animal is destined to live on. The symphisis of the lower jaw in many mammalia remains a synchondrosis throughout life, as in many of the feræ, glires, and cetaceæ. In the human subject they are consolidated at an early period, as also in the quadrumana, some of the pachydermata, and in the horse and horned cattle.

In mammalia the lower jaw only moves, but in birds, serpents and fishes, the upper jaw has more or less freedom of motion.

Attachment of Muscles.—Those arising from the lower jaw are m. depressores labii inferioris, depressores angulorum oris, levatores labii inferioris, buccinatores, mylo hyoidei, genio hyoidei, genio hyoglossi constrictor pharyngis superior; those inserted into it m. temporales, masseteres pterygoidei externi et interni digastrici; and the platysma myoides passing over its horizontal plate.

Use.—The inferior maxilliary bone contains the sixteen lower teeth, and forms the moveable organ for mastication. It also forms the lower boundaries of the mouth, and gives origin to several of the muscles of the tongue, larynx, and pharynx: thus assisting in the functions of speech, swallowing, etc.

Practical Remarks.

The numerous functions in which this bone has an important share, necessarily render its diseases of great pathological interest. From its moveable articulation with the temporal bones, it is liable to the diseases and accidents incident to joints. The formation, growth, and decay of the teeth, are frequent causes of disease in this bone, and in cachectic constitutions, sometimes leads to a malignant action which renders extirpation of half the bone necessary. *(Vide Dublin Hospital Reports, Vol. III.)* The lower jaw is more frequently fractured than any other bone of the face: the accident is generally produced by very severe blows, and may take place in any part of its surface; but each part presents its peculiarity of displacement, from the action of muscles upon it. For instance: when the condyle is detached by fracture through the cervix, the detached portion is drawn forwards and inwards, by the action of the pterygoideus externus muscle: this portion of the bone being so small as to prevent any force being applied to replace it, it is necessary to bring the whole of the bone into the same direction which the fractured portion has assumed, to produce union. *(Vide Fig. 1. Plate I.)* In fractures through the ascending process, but little displacement ensues, in consequence of the extent of attachment of the pterygoideus internus on the inner side, and of the masseter muscle on the outer. *(Vide Fig. 2. Plate I.)* Fractures through the horizontal plate:—In this accident, the fractured portion attached to the chin, is drawn downwards and backwards by the muscles connecting the lower jaw with the os hyoides; and if, in this fracture, a portion of the bone be detached, the deformity is greater, from its being more completely under the influence of these muscles. *(Vide Fig. 3. Plate I.)* In such accidents the fractured portions are to be kept in apposition, by connecting a tooth of each fractured portion with wire, and by keeping the mouth closed; making the upper jaw thus act as a splint. This bone is liable to exostosis; which sometimes acquires a size so considerable, as to interfere with the functions of the bone, and to render its removal necessary. Exfoliation of this bone frequently occurs, from the irritation produced by diseased teeth.

The Os Hyoides,

(υ-ειδοσ, likeness.)

So named from its resemblance to the Greek letter *v*. It is placed horizontally on the fore part of the neck, between the base of the tongue and larynx, and opposite to the space between the third and fourth cervical vertebræ. This bone does not form any part of the skeleton, being merely fixed to the trunk by ligaments and muscles. The os hyoides is divided into its *body*, *cornua*, and *appendices;* all of which are moveable upon one another until advanced periods of life.

The *body* is the central and largest part of the bone, marked upon its external surface, which is convex, by the numerous attachments of muscles, connecting it, above, with the lower jaw and the tongue; below, with the larynx and trunk; posteriorly it is concave; and, through the medium of membrane and fat, it is connected with the epiglottis.

The *cornua* are connected with the extremities of the body, and pass backwards and slightly upwards towards the styloid processes of the temporal bones, to which they are joined by ligament; superiorly, they are connected with the tongue by the hyoglossi muscles; and, inferiorly, by the broad and round ligaments, with the superior cornua, and upper edge of the thyroid cartilage.

The *appendices* are two little projections of bone, which pass upwards and outwards from the junction of the base with the cornua, and assist in giving attachment to some of the muscles connecting this bone with the tongue and jaw.

Muscles arising from the os hyoides are the m. digastrici, hyoglossi, and the constrictor pharyngis superior; those inserted into it, the mylo-hyoidei, genio-hyoidei, genio-hyoglossi, stylo-hyoidei, sterno-hyoidei, omo-hyoidei, and the thyro-hyoidei.

Use.—This bone, under different circumstances, forms a fixed point for the action of muscles of the tongue, jaw, larynx, and pharynx.

Practical Remarks.

The extent of motion of this bone renders it but little liable to fracture. In cases of cut throat, the prognosis is more favourable *(cæteris paribus)* when the incision is above than when it is below this bone. It should be remembered that the cornua are situated between two important arteries, —the lingual above, and the superior thyroideal below.

The Internal Base of the Skull.

Having described separately each bone which enters into the composition of the head and face, and also their respective foramina, it is now my intention more particularly to point out the direction and use of these foramina, with the cavities and fissures into which they open, or to which they lead. The internal surface of the base of the skull, from which all the foramina pass, is divided into three regions:—an anterior, a middle, and a posterior,—to support the corresponding parts of the brain. Of these divisions the anterior is the highest, the middle lower, and the posterior the lowest.

The *anterior* or *frontal region* includes all that part of the base situated in front of the transverse spinous processes of the sphenoid bone; and in this division the following processes, foramina, and depressions, are observed. First, two convexities constituting a large part of the floor of this division, formed by the orbitar processes of the frontal bone; between which convexities—and completing the floor—is situated the horizontal or cribriform plate of the ethmoid bone. From the surfaces of this cribriform plate arises the crista galli, which, passes upwards, to unite with the commencement of the frontal spine, which soon bifurcates to form a groove for the superior longitudinal sinus; at the point of junction of the spine with the crista galli, is placed the foramen cœcum: all these parts give attachment to the falx major. On each side of the crista galli are the *foramina cribrosa,* leading into the superior chamber of the nose, for the transmission of the first pair of nerves, which are here protected from the weight of the brain by grooves formed on its under surface. The depressions on the bone in this division correspond to the inequalities of the anterior lobes of the cerebrum.

The *middle* or *spheno-temporal region* includes that space bounded, before, by the alæ minores and by the processus olivaris of the sphenoid bone; behind, by the posterior clinoid processes and superior ridges of the petrous portions of the temporal bones; and, laterally, by the squamous portions of the temporal, and alæ majores of the sphenoid bone. Several processes, which have already been described as belonging to the internal surface of these bones, are here observable. This division receives the middle lobes of the cerebrum lodged in two deep concavities, situated on each side of the cella tursica. As the *foramina* of this division transmit important nerves, it is of consequence to describe them more particularly, while taking this collective view of the base of the skull. In the first place we notice the *foramina optica*, situated at the roots of the anterior clinoid processes, and leading into the inner and back part of the orbit, directly above the foramina lacera orbitalia superiora. They transmit the optic nerves, and the opthalmic arteries, which enter the orbit above, and to the inner side of the several nerves which pass through the lacerated foramina. Below, and extending considerably outwards, are found the *foramina lacera orbitalia superiora*, which enter the orbit in a direction forwards and inwards, and transmit the third, fourth, first division of the fifth, and sixth pair of nerves; all of which are for the purpose of giving motion and sensation to the eye-ball and its appendages. The opthalmic veins also pass backwards through these foramina, to empty themselves into the cavernous sinuses. The next pair of foramina, which are only separated from the last described by a very small septum of bone, are the *foramina rotunda*. They proceed forwards and slightly downwards to terminate in the spheno-maxillary fossæ, —a cavity which is on either side bounded, before, by the tuberosity of the superior maxillary bone and orbit; on the inner side, by the spheno-palatine foramen leading into the nose; below, by the commencement of the palato-maxillary canal; behind, by the roots of the pterygoid processes and the pterygoid foramen; and, externally, by a large space between it and the zygomatic arch. The foramina rotunda allow the passage of the second division of the fifth pair of nerves, the distribution of the branches of which is easily understood, by referring to the openings just described as leading out of the spheno-maxillary fossa. Behind these, and situated at their outer side, are found the *foramina ovalia*, which open on the external base of the skull, posterior to the pterygoid processes of the sphenoid bone, and to the inner side of the glenoid cavity, immediately in front of a groove which lodges the eustachian tube: they transmit the third division of the fifth pair of nerves, destined to supply the tongue, lower jaw, and the muscles of mastication. The *foramina spinosa*, at the extreme points of the spinous processes of the sphenoid bone, open externally between the foramina ovalia and the styloid process of that bone. They allow of the passage of the middle meningeal artery of the dura mater. At the extremity of the petrous portion of the temporal bones, between them and the sella tursica, is seen an irregular opening for the passage of the carotid artery into the interior of the skull, called the *carotid canal;* which also allows the transmission of connecting branches between the sympathetic and the cerebral nerves. In the recent subject, a considerable quantity of cartilage separates this canal from a distinct fissure, which, in the skeleton, extends between the petrous portions of the temporal bones and the cuneiform process of the occipital: they are termed the *foramina lacera basis cranii anteriora.* They are more obvious on the external than on the internal surface of the skull, and have opening into them the terminations of the pterygoid foramina which transmit the pterygoid nerves, and also a branch of an artery to the dura mater. A groove, passing from this lacerated foramen, leads to the *foramen innominatum,* situated upon the anterior surface of the petrous portion of the temporal bone. This foramen leads to the canal of Fallopius, and gives passage to a branch of the pterygoid nerve. All the parts hitherto mentioned are anterior to the articulation of the head with the spine.

The *posterior* or *occipital region* comprehends all that portion of the base of the skull behind the posterior clinoid processes, and superior ridge of the petrous bones. The processes of this compartment have been sufficiently described, when speaking of the bones which enter into its composition. Contained in this division we have the tract of the grooves for lodging the lateral sinuses: which, beginning at the internal tuberosity of the occipital bone, pass successively over the occipital, posterior angle of the parietal, mastoid portion of the temporal, and again on the occipital bone, to terminate in the foramina lacera basis cranii posteriora. The *foramen magnum,* which is situated in the median line, is proper to the occipital bone, and admits the spinal marrow, its membranes, and also the spinal arteries: it admits, likewise, the vertebral arteries, accessory nerves, and sinus venosus. On each side of this foramen are situated the *anterior condyloid foramina,* which open on the external base of the skull, between the condyloid processes and the foramina lacera. The *foramina lacera basis cranii posteriora* are produced by two sulci, formed into foramina by the junction of the temporal and occipital bones: they are situated on the outer and fore part of the foramen magnum, and appear externally between the anterior condyloid foramina, the fossæ jugulares, and styloid processes of the temporal bones. The posterior condyloid may be seen opening into these lacerated foramina on the external base of the skull, for the purpose of admitting veins which pass through these openings, to terminate in the lateral sinuses. The foramina lacera basis cranii posteriora transmit the internal jugular veins, which are situated to the outer side of the accessory, glosso-pharyngeal and pneumogastric nerves, all of which pass out of these openings: a small artery enters them, to supply the dura mater. On the posterior surface of the temporal bones, three foramina are to be observed: the principal of these are nearest to the median line, and are called the *foramina auditiva interna:* they take a direction outwards, and slightly backwards, into the substance of the temporal bones, but soon divide into two passages: one, the apparent continuation of the foramen, passes to the base of the modiolus, and allows of the passage of the auditory nerve, or portio mollis, into the labyrinth: while the other takes its course upwards, backwards, and, lastly, downwards to terminate at the stylo-mastoid foramen. In its course, being termed the canal of Fallopius, it transmits the portio dura, or facial nerve.

The two other foramina, which are very small, are for the purpose of allowing the evacuation of fluid from the cochlea and vestibule of the internal ear, and are named the *aquæductus cochleæ et vestibuli.*

The External Base of the Skull,

Like the internal, may be divided into three portions, anterior, middle, and posterior. The *anterior* or *ethmoido-frontal* portion, is bounded before by the supercilliary ridges, and behind by the roots of the pterygoid processes of the sphenoid bone. It can only be examined when the bones of the face are separated from those of the cranium; anteriorly and in the middle of this region is found the *nasal process* of the frontal bone, bounded on either side by the *internal angular processes;* behind this process is the *nasal lamella* of the ethmoid bone, bounded on each side by the *ossa tubinata inferiora,* to the outer side of which are the *orbitar processes* of the os frontis, and os sphenoides.

The foramina, which are seen in this aspect and not in the internal base, are the *foramina supra orbitaria,* for the passage of the supra-orbitar nerve of the first division of the fifth pair of nerves, and supra-orbitar branch of the opthalmic artery, *foramina orbitaria interna, anteriora* et *posteriora,* for the passage of branches of nerves and arteries.

Foramina pterygoidea for the entrance of the pterygoid nerves from Meckell's ganglion, and the *openings* of the frontal, ethmoidal and sphenoidal sinuses.

The foramina, which may be observed both on the external and internal base, are, *foramina optica, foramina lacera orbitaria superiora,* and the *foramina rotunda.*

The *middle* or *sphenoido-temporal* division, is bounded before by the pterygoid processes of the sphenoid, and behind by the styloid processes of the temporal bones. In the middle of this division is seen the azygos process of the sphenoid bone, bounded on either side, and rather posteriorly by the pterygoid processes of the same bone, and behind by the cuneiform process of the occipital bone; still further, on the outer side of this region, are seen the petrous portions of the temporal bones, the spinous processes of the spenoid and the glenoid cavities, bounded in front by the roots of the zygomatic, and behind by the auditory processes. The foramina seen in the external aspect of this division only, are, the *foramina auditiva externa*, the *foramina glenoidea*, and the *foramina eustachii* while; those which are seen internally as well, are the *foramina ovalia*, *foramina spinosa*, and the *foramina carotica*.

The *posterior* or *occipital* division is bounded before by the styloid processes of the temporal bones, and behind by the occipital. In its centre is seen the *foramen magnum;* on the sides of which anteriorly are placed the condyloid processes, and in front of these, on either side, are the styloid and vaginal processes of the temporal bones, bounded behind by the mastoid processes and digastric fossæ. The posterior boundery of the occipital division is marked by the superior and inferior transverse arches, the spine, and external protuberance of the os occipitis. The foramina seen on the external aspect of this division only, are, the *foramina stylo-mastoidea* and the *foramina mastoidea*; and on both aspects, the *foramen magnum*, *foramina lacera basis cranii posteriora*, and the *foramina condyloidea anteriora et posteriora*.

Important Cavities produced by the Bones of the Face.

The Orbits

Are two large cavities, situated on either side of the nose, immediately below the supercilliary ridges. They are of a conical form; their base being in front, and the apex behind. Their direction is from behind to before, and somewhat from within to without; which circumstance tends much to enlarge the field of vision: but this advantage, perhaps, may be considered as secured by the cavity of the bony orbit being much larger than the ball of the eye itself.

Each orbit is composed of seven bones, although but eleven enter into the composition of the two; which apparent paradox is explained by three of the bones being *common* to the two orbits, viz.:—the frontal, the ethmoid, and the sphenoid.

The relative position of these bones, in the composition of each orbit, is as follows:—The os frontis is situated above, and forms the whole of the *roof* of the cavity: the *floor* is produced by the orbitar process of the superior maxillary bone. The malar and sphenoid bones constitute the *outer* *wall:* the *inner wall* receives the unguis and ethmoid bones: and lastly, the palate bone completes the small *posterior part* or apex of the orbit. In each orbit are found several foramina, for allowing the passage of blood-vessels, nerves, and absorbents, to and from the eye and its appendages. At the posterior part two are placed — the *optic* and *lacerated foramina*, which have already been particularly described in speaking of the base of the skull. Above the orbit is situated the *supra-orbitar foramen:* allowing the passage of a branch of the first division of the fifth pair of nerves, to supply the parts about the eye-brow, upper lid, and inner canthus of the eye. From the floor passes out the *infra-orbitar foramen;* which gives passage to a branch of the second division of the fifth pair, supplying sensation to the parts about the face. From the inner side, two small foramina lead into the interior of the skull: they are situated in that part of the transverse suture, formed by the union of the ethmoid and frontal bones: the anterior one transmits a twig of the first division of the fifth pair of nerves, and a branch of the ophthalmic artery, which pass through some of the anterior foramina of the cribriform plate of the ethmoid bone into the nose. This distribution explains the watering of the eyes, upon any pungent substance being applied to the nose. The posterior foramen admits only a branch of the artery which goes to supply the dura mater. These foramina are named the *foramina orbitalia interna, anteriora*, and *posteriora.* On the outer side of the orbit is placed the *foramen lacerum orbitale inferius*, or *spheno-maxillary fissure;* which is bounded above, by the sphenoid bone; below, by the superior maxillary; anteriorly, by the malar; and posteriorly, by the palate bone. It leads from the spheno-maxillary fossa, and admits the infra-orbitar nerve and artery, which pass through the floor of the orbit, and infra-orbitar foramen, to the face. The malar foramen also opens into the orbit.

The form of the orbit differs very much in different animals, in direction and capacity. In the simiæ, they approach each other, but are directed forwards, as in the human species. In some of those mammalia, which have their orbits open at the back part, to communicate with the temporal fossæ, the malar bones only form the zygomatic arch by uniting with the temporal bones, and are not connected to the sphenoid and frontal bones: such is the case in the carnivora, rodentia, edentata, and pachydermata; and moreover, in them the superior maxillary bone merely forms the anterior rim of the orbit, without constituting the floor, which is open below; and the ossa palata, which are large, form a considerable share of the inner part of the cavity, the ethmoid bone not contributing to it. Ruminating animals, and also the horse and ass, have the margin of the orbit complete; but still open, posteriorly, into the temporal fossæ.

Practical Remarks.

Exostoses sometimes grow from the orbitar processes of the bones forming the orbits, and destroy vision by pressure on the eye-ball. This disease may be mistaken for some malignant affection of the eye itself; but the diagnosis may be formed by close examination, before the naturally transparent parts of the eye have become opaque; for if the disease be of the eye itself, it will be observable, by a shining like some metallic substance at the bottom of the organ: while, on the contrary, if it be exostosis, it is situated behind the sclerotic coat, and cannot therefore be discovered.

The Lachrymal Fossæ

Are placed on the inner side of the orbits, and lead into the lower chamber of the nose, as a long canal. They are formed by the ossa unguis, the nasal plates of the superior maxillary, and by processes of the inferior spongy bones. They contain the lachrymal sac and duct, which are continuous with the tunica conjunctiva above, and the pituitary membrane of the nose below.

Practical Remarks.

The duct is sometimes obliterated, and suppuration takes place in the sac, producing the disease termed fistula lachrymalis; the cure for which is to pass an instrument from the sac through the duct into the nose, and thus render the passage again pervious. This operation is performed by laying the sac open immediately below the attachment of the tarsi, to the nasal process of the superior maxillary bone: but, in doing this, care should be taken not to use so much force as to injure the delicate structure of the os unguis. A style is then passed down the duct, and allowed to remain there until the passage of the tears is perfectly re-established.

The Nostrils.

By this term is meant the bony part of the nose, forming the osseous cavity, for the protection of the more delicate structures which enter into the composition of the true organ of smell: for the cartilages, and softer anterior parts, are to be considered as subservient to the respiratory functions, which the nose assists in performing, rather than to the olfactory function.

There are fourteen bones which enter into the formation of the bony part of the nose, and which are placed in the following relative position:—The anterior convex part, which is termed the bridge of the nose, is formed by the ossa nasi, the nasal processes of the superior maxillary bones, and by the ossa unguis: the *roof* of the nose, by the under surface of the cribriform plate of the ethmoid bone: the *floor,* by the palatine processes of the superior maxillary and palate bones: while the *bony septum* is produced by the nasal lamella of the ethmoid bone, the vomer, the azygos process of the sphenoid bone, and by the nasal spine, assisted by the union of the palatine processes of the superior maxillary and palate bones. The cavity of the nose is rendered irregular by the inferior turbinated bones. This large cavity is divided into three chambers: —a *superior, middle,* and *inferior.*

The *superior chamber* is contained entirely in the ethmoid bone, being situated between its cribriform plate and turbinated portion. This chamber has opening into it the *posterior ethmoidal* and *sphenoidal sinuses.*

The *middle chamber* includes that portion bounded above by the superior turbinated bone, and below by the inferior, and into which open the *frontal* and *anterior ethmoidal sinuses,* by a common foramen: and also the *antrum highmorianum.*

The *inferior chamber* is placed below the inferior turbinated bone, between it and the palatine processes of the superior maxillary and palatine bones. The *ductus ad nasum* terminates in this cavity, immediately underneath the inferior turbinated bone.

An anterior opening, common to the three chambers, forms what is generally called the nostril; while it terminates behind, also, by a common opening into the upper part of the pharynx. The whole of the interior of the nose, as well as the sinuses communicating with it, are lined by the pituitary membrane. It is to be remembered that the nose is a double organ, and that therefore the parts described are found on each side of the septum.

The general form of the nose and the complexity of its interior differs much in various animals, and even in varieties of the same species; to exemplify this, make a vertical section through the centre of the nose of a foxhound, and a greyhound, when the full development of the organ of smell in the former will carry with it the conviction of the animal's fitness to follow its prey by scent, while in the latter, the contracted nostrils proves satisfactorily its inability to rely on its olfactory powers.

The practical remarks connected with the organ will be better understood, when its relative position with the pharynx and the soft parts entering into its composition has been described.

The Mouth.

The osseous parts of this cavity are formed above, by the superior maxillary and palate bones, constituting the hard palate or roof of the mouth: laterally and below, by the inferior jaw. The teeth also form a considerable portion of these boundaries.

The Teeth

Are situated in the upper and lower jaws; at the adult period of life they are thirty two in number. They are the only bones which are not covered by soft parts, but are, however, protected from the influence of the atmosphere, and substances with which they are brought in contact during the process of mastication, by a peculiar hard substance termed the enamel. They are divided into four distinct classes, named either from their use or form, but each class bears its respective distinctions.

The thirty-two teeth are composed of eight incisores, four cuspidati, eight bucuspides, and twelve molares.

The eight *incisores* are named from the latin word, *incido* to cut and are situated on the anterior part of each jaw, two being placed on either side of the mezian line, they are characterized by having one fang, and by the body presenting an external convex and an internal concave surface, terminating in a cutting edge.

The four *cuspides* or *cuspidati* are named from their form, *cuspes* a spear, but they are also sometimes called the dentes canini; one of these teeth are situated on each side of the outer incisor teeth of both jaws; they possess but one fang, and the body terminates in a rounded point, so that they present somewhat a resemblance to an incisor tooth, with its angles ground off. They seem to be intended for the purpose of rather holding than cutting the food.

The eight *bicuspides* are so arranged that two are placed on the outer side or behind the cuspidati on each side of both jaws; they are named from their bodies terminating by two distinct points, but they are only furnished with one fang. They seem to partake somewhat of the properties of both the cuspidati and molares; of the former in tearing, and of the latter in triturating the food.

The twelve *molares* are named from *mola* a mill, it being their office to grind the food. There are three on each side of each jaw, the posterior of which are termed the dentes sapientiæ, in consequence of their not making their appearance until the period when persons are supposed to have arrived at the age of reason. Their bodies terminate in three or four distinct prominences, and they are furnished with three or four fangs in the upper jaw, but only two in the lower.

The teeth in the human subject seem to be wholly designed for the purpose of mastication, but in the lower animals they are frequently destined to perform other offices, and may be considered equally useful, as weapons of offence and defence, as may be observed in the tusks of the elephant, wild boar, &c. hence arises great varieties in their form, as well as from the circumstances of the teeth being modified in their arrangement and shape to adapt them to the preparation of the different kinds of food for deglutition; so that in the study of comparative anatomy there is no part of the skeleton of an animal which offers more zoological interest than the teeth.

Practical Remarks.

The numerous diseases to which the mouth is liable, arising from the various structures which enter into its composition, render it more desirable to defer their consideration until each structure is separately described.

LECTURE III.

THE BONES OF THE TRUNK.

THE bones of the trunk form the second division of the skeleton, and are subdivided into the bones of the *spine*, the *thorax*, and the *pelvis*.

First Division of the Trunk.

The Spine.

The *spine* is a part of the skeleton invariably found in all red-blooded animals, and is composed of twenty-four separate bones termed the vertebræ, which are comprised under that class named the irregular bones. In conjunction they form a pyramidal pillar, its base resting on the pelvis, and supporting the head by its apex. It forms a canal along its whole length, to contain the spinal chord.

Each vertebra is characterized by its *body, bony arch, seven processes, two pair of notches*, and a *hole* for the spinal marrow. The *body* constitutes the principal part of the bone, and is situated anteriorly: its circumference is more or less rounded, having a slight concavity behind, to assist in forming the spinal canal: it is flattened above and below, for its connexion with the intervertebral substance. The texture of this portion of the bone is spongy. The *arch* is formed by two small processes of bone, passing backwards and inwards, and meeting in the median line; thus completing the *hole* for the spinal marrow. Of the seven processes, the first to be observed are the two *transverse*, which proceed from the arch, close to its junction with the body of the bone: they extend outwards with more or less obliquity, are of a compact structure, and are marked by the attachments of numerous muscles. The *articulatory processes* are four in number; two being situated above, and two below the transverse processes: the upper have a direction more or less backwards, and the lower ones forwards; thus forming a junction with the corresponding processes of the vertebræ above and below. The surfaces which come in contact with each other are covered with cartilage. From the centre of the arch, posteriorly, projects the *spinous process*, passing backwards and downwards with various degrees of obliquity. This process is of the same compact texture as the whole of the arch, and gives attachment to muscles. The *two pairs of notches* are situated above and below, between the body and articulatory processes. The inferior are the deeper of the two; and, by the junction of the vertebræ, they are formed into foramina, for the transmission of nerves from the spinal marrow. These are characteristics common to all the vertebræ: but, as they vary according to their situation and mobility, the column is divided into three distinct regions, viz.:—the *cervical*, *dorsal*, and *lumbar*. The vertebræ have derived their name from *verto* to turn, and in serpents they are articulated by ball and socket joints which add amazingly to their flexibility.

The Cervical Region

Is composed of seven vertebræ, and is placed between the chest and the head. The vertebræ of this region may be known by the following distinguishing marks:—The *body* bears a comparatively smaller proportion to the whole bone than in the other regions; it has its long axis extending laterally, it is hollowed above, from side to side, whilst below, it is hollowed from before to behind: the fore part of the body is flattened, to enlarge the surface of contact with the pharynx and œsophagus. The processes which form the arch are broad and large, extending so far backwards from the body as to render the spinal *hole* large and triangular. The *transverse processes* are short, and extend directly outwards: their extremities are bifid, and they are pierced at their roots by the *vertebral foramina*, which give transmission to the vertebral arteries and veins. The *articulatory processes* are placed rather behind the transverse; the *superior* are directed backwards, upwards, and rather inwards; the *inferior* forwards, downwards and outwards. The *spinous process* is short, projects backwards, with a very slight obliquity downwards, and, like the transverse processes, terminates in a bifid extremity —thus affording an increased surface for the attachment of muscles. A cervical vertebra may be easily known, by any one of these peculiarities: but the grand distinction, by which it may immediately be recognized, is the *vertebral foramen* in its transverse process.

Amongst the seven cervical vertebræ we find three differing from the rest, so as to require a peculiar description. These are the first, the second, and the seventh. The two former should be minutely examined, since, by their connexion with the occipital bone and with each other, they allow of the motion which takes place between the head and the spine, and regulate its extent. The *first cervical vertebra*, usually called the *atlas* (from ατλαω to sustain), forms an exception to the general description of these bones, as we can neither recognize body, nor spinous process. It consists merely of a bony ring, forming the commencement of the vertebral canal. The internal circumference of this ring is rendered still more concave anteriorly, by being furnished with an *articulatory surface* to receive the dentiform process of the vertebra below. Behind this hollow the bone is marked on each side by a small *tubercle* for the attachment of the transverse ligament, which passing behind the dentiform process confines it to its situation. This ligament may be said to divide the ring into two compartments, the anterior of which is the smaller, and lodges the dentiform process: the posterior is continuous with the circumference of the foramen magnum, and transmits the spinal marrow. The upper surface of the ring presents two *articulatory concavities*, converging anteriorly, and corresponding with the condyles of the os occipitis, which they receive. The bone is *rough* both before and behind these cavities, to give attachment to ligaments which connect it with the occiput. Only a slight motion, backwards and forwards, is allowed between these two bones. The *inferior articulatory processes* are flat, placed nearly horizontally, and face downwards and slightly inwards. The *transverse processes* are very large, but do not bifurcate at their extremities: a very *slight projection* occupies the place of the spinous process. The notches of this bone are placed behind the articulatory processes. The atlas is very large in all the feræ.

The *second cervical vertebra*, or *dentata*, is immediately distinguished by its strong and compact tooth-like projection, called the *dentiform*, or *odontoid process*, which rising upwards from the body of the bone, is received into the hollow of the atlas, anteriorly to the transverse ligament, where it is allowed to rotate; its surface is *smooth* before to articulate with the vertebra; *smooth* also behind to articulate with the ligament; its extremity is *rough*, for the attachment of ligaments connecting it with the edges of the foramen magnum. The *superior articulatory processes* are flat, and face upwards and outwards, corresponding with the inferior of the atlas, and allowing an extensive rotatory sliding motion between these bones. The *transverse processes* are small, and point downwards, so as not to interfere with the lateral motion of the two first vertebræ. The *spinous process* is large and strong. The *spinal hole* is triangular. The *superior notches* are placed behind the articulatory processes, and are very slightly marked. The *inferior* are situated, as in the other vertebræ, between the articulatory processes and body of the bone. All the lateral horizontal motions of the head are effected between these two vertebræ, during which the dentiform process rotates in the cavity of the atlas, and the articulatory processes of the two bones slide the one upon the other. To allow of this motion, the atlas and vertebra dentata are not connected with each other by an intervertebral substance. The dentiform process is very large in the feræ.

The *seventh cervical vertebra* differs from the rest, by approaching somewhat in its form to those of the dorsal region, and may be considered as a sort of link between the two divisions, which it unites. Thus we find its *body* larger and more rounded. Neither the *transverse* nor *spinous process* are *bifid*, whilst the latter is lengthened and inclined somewhat downwards. The grand characteristic, however, still remains, viz., the *vertebral foramen*, which here transmits, not the vertebral artery, but its corresponding vein; the artery passing before the transverse process of this vertebra, which it sometimes slightly grooves. The spinous processes of the cervical vertebræ are short, particularly in long necked animals. It is remarkable that the number of cervical vertebræ in all mammalia is the same; in the giraffe, and in the mole, seven vertebræ form their neck. The three-toed sloth had been thought a variety from this rule, but my friend, Mr. T. Bell, has shewn that this animal has but seven, and that the supposed additional two are, in fact, dorsal vertebræ.

The Dorsal, or Thoracic Vertebræ,

Are *twelve* in number. They form the posterior boundary of the cavity of the thorax, and support the ribs. A general description of them offers the following distinguishing marks. They are much *larger* in every direction than the cervical. The *body* has its long diameter from before to behind; is *prominent* anteriorly, and somewhat *concave* from above to below: its superior and inferior surfaces are flattened. On each side of the body, just anterior to its junction with the arch, we observe two half *articulatory surfaces:* one at the upper edge and one at the lower. These, by joining with corresponding surfaces on the vertebræ above and below, form the *articulatory cavities* for receiving the heads of the ribs: so that the head of each rib is received between two vertebræ, to both of which it is articulated. The *arch* is strong, and almost entirely occupied by the processes which arise from it: it is smaller than the cervical vertebræ, and the *spinal foramen* is consequently reduced in size, and *rounded.* The *transverse processes* are strong, projecting horizontally outwards and backwards: they are deeply marked by the attachment of muscle and ligament, and on the anterior surface of their extremities is an *articulatory depression* for receiving the tubercle of that rib, the head of which is connected with the superior cavity on the side of its body. The transverse processes increase in length, and have a tendency to incline downwards from the first to the seventh, below which they again become shorter and more horizontal. The transverse processes of the eleventh and twelfth are particularly small, and do not articulate with the ribs. The *articulatory processes* of the dorsal vertebræ are placed vertically; the *superior* directed *backwards* and slightly *outwards;* the *inferior, forwards* and slightly *inwards:* their surfaces are flat.

The *spinous processes* are long, and pass with great obliquity downwards. Their posterior surface presents a sharp ridge, to receive which there is generally a groove on the under surface of the process above. The spinous processes of the dorsal vertebræ increase in length, and incline more downwards from the first till about the eighth, below which they become shorter and more horizontal, resembling those of the lumbar region. The spinous processes of the three upper dorsal vertebræ are longer than the rest, to give firmer attachment to the ligamentum nuchæ.

The *notches* are large, and particularly the lower ones. There are in this region, as in the cervical, some distinguishing marks, by which certain vertebræ of this class may be recognized: the *first, tenth, eleventh* and *twelfth,* are of this description. The *first* presents, on each side of its body, two articulating surfaces,—a whole one above for the first rib, and a half one below for the second. The *tenth* has a single half-articulatory surface only, on the upper edge of each side of its body, for the junction of the tenth rib.

The *eleventh* and *twelfth* dorsal vertebræ are alike; both having an entire articulatory surface on each side of their bodies for their respective ribs, and having none on their transverse processes: but they may be known from each other by the *twelfth* having its inferior articulatory surfaces directed outwards, and somewhat convex; resembling, therefore, in that respect, the lumbar vertebræ.

The grand distinguishing mark of the dorsal vertebræ is the articulating surfaces, for the attachment of the ribs. The number of the dorsal vertebræ varies much in different animals, but always depend upon the number of ribs; some animals have fewer than man; the bat, for instance, only eleven. In the human subject thirteen dorsal vertebræ is sometimes found, but with it always a supernumerary rib.

The Lumbar Vertebræ

May be at once known from the rest by their greater size, and also, negatively, by not being furnished either with a foramen through their transverse processes, or with articulating surfaces for the ribs. Their *body* bears a great proportionate size to the whole of the bone, which has its long axis from side to side, and is slightly concave from behind to before, both upon its superior and inferior surfaces. Their *articulatory processes* are large and elongated: the *superior* are concave, oval in form, and are directed backwards and inwards, having rather a tendency to converge: the *inferior*, on the contrary, rather diverge, are convex, oval, and face forwards and outwards, admitting a considerable degree of lateral motion. Their *spinous process* is large, long, takes a horizontal direction backwards, and is flattened laterally. The *transverse processes* are thin, long, and pass horizontally outwards, having a slight inclination upwards: they are placed on a plane anterior to the transverse processes of the dorsal region. Their *spinal hole* is large and triangular; and their *notches* form very deep sulci. The *fifth* lumbar vertebra may be known from the rest of this region by having the lower surface of its *body* oblique, so that the anterior part of its body is much deeper than the posterior: and also, from having the extremity of its *spinous process* hooked downwards towards the sacrum. The remarkable increase in the size of the lumbar vertebræ, from the additional weight this region has to sustain is one of the strong anatomical indications of the necessity of the erect posture in man.

The Spinal Column.

The union of these twenty-four bones constitutes the *vertebral column:* the *use* of which is, to support the head, to form a part of the chest, to protect the spinal marrow, and to offer an extended surface for the attachment of muscles. Of the mechanism by which it is so perfectly adapted to its numerous offices, I shall defer to treat until I speak of the skeleton in general: for the functions of the spinal column can be neither appreciated nor understood, by abstract and insulated considerations. It ought, however, to be borne in mind, that the spine forms the great medium of connexion between all the parts of the body; and that, necessarily, numerous muscles are attached to its whole length.

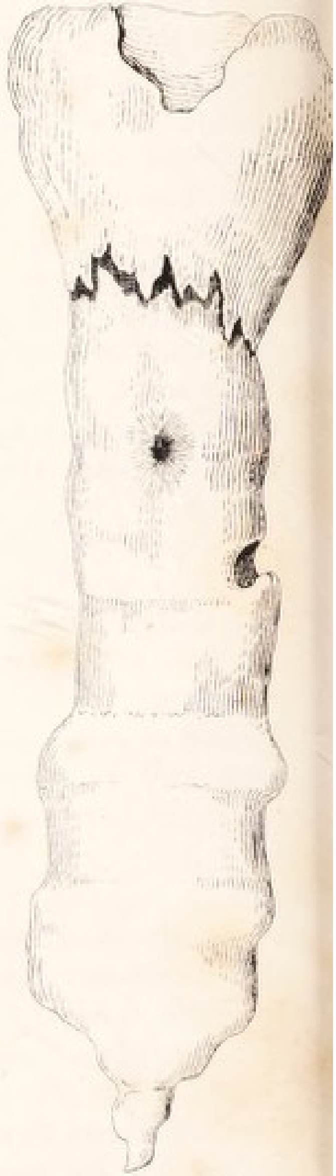
Attachment of Muscles.—Those muscles attached to the spine are principally for the purpose of keeping the trunk and head erect, and many of them moreover are muscles of respiration. The are placed in

Page 21.

Plate 2.

Fig 1.

Fig 2



Warr lith:

the following order:—*Posteriorly* are found the m. trapezii, latissimi dorsi, rhomboidei majores et minores, levatores scapulæ, serrati postici superiores et inferiores, splenii, sacro-lumbales, longissimi dorsi, spinales dorsi, cervicales descendentes, transversales colli, trachelo-mastoidei, complexi, recti capitis postici majores et minores, obliqui capitis superiores et inferiores, semispinales dorsi, semispinales colli, multifidi spinæ, intertransversales et interspinales colli, dorsi et lumborum, levatores costarum, obliqui abdominis interni. In the *anterior region*, m. longi colli, recti capitis interni majores et minores, recti capitis laterales, diaphragma, quadrati lumborum, psoæ magni et parvi. *Laterally*, m. scaleni antici, medii et postici, and the transversales abdominis.

Practical Remarks.

Fractures of the spine are difficult to detect, from the little displacement which occurs: but the best mode of examining a patient who has suffered from this accident, is to place him with his face downwards; and by pressing the palm of one hand firmly on one side of the spine, trace the spinous processes with the other from the neck to the sacrum. When you arrive at the displaced vertebra, you will find it thrown a little out of its line, where a hollow in the part is perceptible.

Symptoms.—Paralysis immediately ensues of all the parts beneath the injury: and it is remarkable, that when this accident occurs in the male, that the penis is found in a half erected state. The abdomen is tympanitic, the fæces are passed involuntarily, and the urine is retained: the latter symptom, however, in cases where the sufferer lives for a considerable length of time, becomes changed to an involuntary discharge. The passing away of the fæces is to be explained by the paralysis of the sphincter ani, and the continued peristaltic action of the intestines: while the muscular coat of the bladder, being no longer stimulated by the accumulation of urine, is rendered incapable of contraction, and the water is consequently retained. There is no instance recorded of a permanent recovery from this accident; as it seems impossible that the vertebræ should be fractured, without mischief to the spinal marrow. When the lower part of the spine is the seat of injury, the patient will, in some cases, live for six weeks, or even longer; but when the fracture happens above the fourth cervical vertebra, death immediately ensues. If the fracture takes place at the bottom of the neck, the patient may survive nine or ten days. These results depend upon the degree of interrupted function, which the nerves distributed to the muscles of respiration experience. The late Mr. Henry Cline recommended the removal of the depressed portion of the vertebra, upon the same principle that trephining is employed in fractures of the skull; and he performed the operation in one case, but unsuccessfully. Mr. Frederic Tyrrell has since performed it in two instances, with a like want of success. *Vide Plate* 2, *Fig.* 1., in which the position of the spinous process of the fractured vertebra is delineated.

Second Division of the Trunk.

The Thorax.

(Θωρεω to leap.)

The *chest* is a large conoidal cavity, placed anterior to the twelve dorsal vertebræ: it is composed of bones, to give it firmness; of cartilage, to render it flexible; and of ligaments, to tie those parts together. The bones which enter into its composition may be thus enumerated:—The *sternum*, forming the anterior boundary, and placed in the median line of the body: twelve *ribs*, situated on each side of it, which are more or less connected with the sternum in front, and with the twelve *dorsal vertebræ* behind. The dorsal vertebræ form the posterior boundary to the chest.

The form of the chest is different in man from that of any other animal, its lateral dimensions preponderating; thus preventing the weight of the thorasic viscera pressing too much forward so as to interfere with his erect posture. In quadrupeds the chest is much narrower and deeper from the sternum to the spine, contracting inferiorly, so as to form what has been termed *thorax carinatus*. The form of the chest has also a very material influence upon the power of vomiting, when the ribs extend very low down, as in the horse, or the diaphragm is placed very high up, as in the rabbit; the abdominal muscles are unable to act upon the stomach, so as to force out its contents.

The Sternum.

(Sterno, to pave, or flatten.)

This bone is situated in the middle line of the body, and is divided in early life into three portions, which are not connected with each other by bone until the adult period. They are, however, so firmly united by cartilage as to move, during respiration, as a single bone.

The *upper* piece of the sternum is somewhat of a triangular form, the base being placed above, and the apex below. It is, superiorly, *notched*, so as to give it somewhat the appearance of a heart: on each side of which notch is situated an *articulatory surface*, for the junction of the clavicles. On each of its lateral edges are placed *one whole* and *one half* articulating surface, for the perfect attachment of the cartilages of the first rib, and for half of the second. The *inferior edge* is rough, for its connexion with the second piece. *Anteriorly* this portion of the sternum is *flattened: posteriorly* it is *concave*, to enlarge the upper part of the chest, for the passage of the œsophagus and trachea.

The *middle piece* is nearly of the same thickness and breadth throughout its whole length: it forms by far the most considerable portion of the sternum. Its *superior edge* is attached to the upper piece. *Inferiorly* it is connected with the lower portion; and laterally it offers, on each side, a *half articulatory surface* for the second rib; a *whole* one for the third, fourth, fifth, and sixth; and *half* of one for the seventh.

The *inferior piece* is usually found cartilaginous at its extremity, which is termed the *ensiform cartilage*. It is smaller than either of the others, and presents but *half* an articulating surface on each side, for the attachment of part of the cartilage of the seventh rib.

The *use* of the sternum is to assist in forming the thorax, and to defend the heart and lungs. It forms a medium of attachment for the ribs, acts as a fulcrum for the clavicles to roll on, and gives attachment to several muscles.

The form of the sternum, in most mammalia, is cylindrical, and jointed: this is the case particularly in the quadrumina. In the mole its form is very peculiar; it extends forward under the cervical vertebræ, offering a very extensive surface for the attachment of the muscles of the anterior extremities.

Attachment of Muscles to the sternum are the m. pectorales majores, sterno-mastoidei, sterno-hyoidei, sterno-thyroidei, subclavius sterno-costalis, diaphragma, obliqui abdominis interni, the recti abdominis, and intercostales interni.

Practical Remarks.

The degree of motion which the sternum enjoys, from the elasticity of the cartilages of the ribs to which it is connected, secures it from the frequent occurrence of fracture. Nevertheless, this accident does sometimes occur, from the application of a concentrated force; and an effusion of blood into the surrounding parts is the consequence. But little displacement of the fractured portions of the bone occurs, in consequence of the elasticity of the cartilages of the ribs. If the bone be comminuted, and driven inwards, it may interfere with respiration, and render it necessary to remove the fractured portion with a trephine. *(Vide Plate II., Fig. 2.)* Suppuration subsequent to this accident might also produce symptoms warranting such an operation. In a case of simple fracture of the sternum, a bandage should be applied round the chest, with a degree of pressure sufficient to prevent the action of the intercostal muscles; and a patient should be placed in a position, with the head and pelvis raised: in this manner the sternum is removed, as it were, from the influence of muscles. It is almost invariably right to abstract blood from the arm: at any rate, the antiphlogistic regimen is essential. Abcess in the anterior mediastenum may be mistaken for aneurism, from the vicinity of the matter to the heart; the strictest attention should therefore be paid to the history of the case before proceeding to evacuate the tumour.

The Ribs.

The *ribs* consist of a succession of long slender bones, which form the sides, and great part of the posterior boundaries of the thorax. They are twenty-four in number; twelve of which are placed on each side. They are attached, by their posterior extremities, to the twelve dorsal vertebræ. Anteriorly, they form a junction with the sternum, by means of an intervening cartilage; whilst below, they are attached to each other by a similar structure. The difference observable in their anterior articulation, distinguishes the ribs into two classes; the *true* and the *false ribs*. The true ribs, comprising the seven superior, are connected successively with the three portions of the sternum; into the articulatory cavities of which bone their cartilages are received, and thus form more particularly the walls of the thorax. The five inferior, or false ribs, may be considered as forming a part of the abdominal parieties, as they defend the viscera in the upper part of that cavity. They are not continued forwards, as far as the sternum, but terminate by each joining its cartilage to that of the rib immediately above: the two last are to be excepted, which, from having their extremities unattached, and merely tipped with cartilage, have received the name of floating ribs. The length of the ribs increases successively from the first to the seventh, and then gradually diminishes to the twelfth: the first is placed horizontally, while the others are more or less inclined downwards from the vertebral column. They all diverge in passing from the spine, and converge in passing to the sternum. No two ribs on the same side are alike; but, as a general description, we distinguish on each the following parts:—A *head*, a *neck*, a *tubercle*, an *angle*, a *body*, and an *extremity*. The *head* forms the posterior or vertebral extremity of the bone; is somewhat spread out; and on it we observe two *articulatory surfaces*, divided by a ridge. These surfaces are received into the articulatory cavities on the bodies of the two dorsal vertebræ, between which each rib is placed; while the *interarticular ridge* corresponds to the intervertebral substance, with which it is connected by ligament. Anteriorly to the head, the rib becomes contracted and somewhat rounded, forming what is called the *neck*. This part is about an inch in length, roughened for the attachment of ligaments, and extending downwards and outwards, terminates in a little rounded eminence, situated at the back part of the bone, called the *tubercle:* this tubercle has a convex *articulatory surface*, to be received into a corresponding cavity, situated on the transverse process of the lower of the two vertebræ with which the head is connected. Both the neck and the circumference of the tubercle are rough, for the attachment of ligament and tendon. The remaining portion of the rib is called the *body*, which, after passing for a short distance in the same direction as the neck, turns suddenly forwards, and thus produces a very considerable curve, which is called the *angle;* the position and shape of which are different in each rib. Beyond the angle, the body is found to pass forwards, with a gentle curve, towards he sternum, at a short distance from which it terminates in what is called the *extremity*. The body becomes flattened immediately after leaving the tubercle, and presents two smooth surfaces: the external convex, and the internal, concave, for the purpose of enlarging the thoracic cavity. Its superior edge is rounded and smooth; its inferior, sharp, and grooved internally, to receive the intercostal artery, veins, and nerve. This groove commences at the tubercle; and, becoming gradually less distinct, is lost about the middle of the bone. Both the edges give attachment to the intercostal muscles. The extremity of the rib is slightly expanded, of a spongy texture, and hollowed, to receive the cartilage, with which it is inseparably connected. These cartilages are not continued in the same direction as the ribs themselves, but pass very obliquely upwards, so as to form, by their junction with the sternum, an angle, obtuse above, and acute below. This inclination of the cartilages upwards, increases from the first rib downwards. Lastly:—In viewing a rib, we observe that it presents a *twisted* appearance, as if the two extremities had been turned in a contrary direction. The degree of this twist varies in each rib in such a manner, that the rib shall always present its flat internal surface towards the lung, under the different motions which each exerts during respiration; and thus, although the size of the thoracic cavity is altered, its plain continuous surface is preserved.

Having described the general character of the ribs, it will be proper to mention some of the number which, from certain peculiarities, may be distinguished from the rest: for although every rib varies somewhat from its neighbour, either in form or position, yet the gradations of difference are so slight as to render it difficult, or almost impossible, to name the precise condition of each. We may, however, recognize the *first*, the *seventh*, the *ninth*, the *eleventh*, and the *twelfth*. The *first* is known by its small size and incurvating form, completing about half of a circle: it is very broad and flat, one of its two *surfaces* facing *upwards*, and the other *downwards*. On the superior surface there are two slight grooves, making the course of the subclavian artery and vein; between which a small *tubercle* is situated, for the attachment of the scalenus anticus muscle. Its *angle* and *tubercle* are situated on the same spot. Its *head* has only one articulatory surface, corresponding with that on the first dorsal vertebra.

From the first the ribs increase in length to the *seventh*, which is the longest of all, and may be known by that circumstance, After this, they again decrease to the last. The distance between the *tubercle* and the *angle*, and indeed the curve of the angle itself, will be found to *increase* regularly from above to below, as far as the *ninth*, where they both attain their maximum: which enables us to distinguish that particular bone. In the two or three superior ribs the angle is hardly to be recognized at all, it is so involved in the general curve of the rib: the same remark also applies to those below the ninth. The *eleventh* and *twelfth* ribs are distinguished by having *whole* articulatory surfaces on their heads, to correspond with the two lower dorsal vertebræ; but as they do not articulate with the transverse processes of the corresponding vertebræ, they are *destitute* of tubercles: their extremities are likewise unconnected. The curve formed by the bodies of the ribs will be found gradually to diminish, from the first to the last; and the tubercles will be seen to face in a more downward direction in the same ratio.

Having thus given a description of the several ribs, and mentioned the peculiarities of each, we may next take a view of the cavity formed by them laterally, by the sternum, before, and by the dorsal vertebræ, behind. This cavity is of a conical shape, having its apex above, and its base below; a form which will at once indicate the differences which must exist in each bone, in order, by their combination, to produce it. Thus we find the curve of the ribs diminishes, while their length increases, from above to below. It is true, that, after the seventh, they again become shorter; but this does not interfere with the general contour of the cone: for, as their curve still continues to decrease, the only effect produced by their diminution in length is, that they terminate sooner, and thus leave the fore part of the cavity defective below; just as if an oblique section had been made of the cone, from above to below, towards the spine. The direction, also, of the two surfaces in the different ribs, the situation of the angles, the obliquity of the cartilages, and all the other variations already described, will be found contributory to the production of a conical cavity, and to the adaptation of that cavity to the different degrees of motion, and alterations in size and shape, which it is destined to undergo during respiration.

It is worthy of remark that the ribs do not run in lines parallel with each other, but have a tendency to diverge as they pass from their spinal articulations. Their cartilages, on the contrary, converge as they pass forwards and upwards, being brought almost in contact with each other, where they reach the sides of the sternum. Thus if we draw three lines from the top to the bottom of the thoracic cavity, one through the bony extremities of the ribs, another through their heads, and a third through the sternal extremities of their cartilages, the first line will be found the longest, the second shorter than the first, and the last shortest of all. This circumstance refers more particularly to the seven true ribs. The peculiar motion

Plate 4.

Warr lith.

Plate 3.

Warr lith.

of the ribs during respiration, and the manner in which this motion tends to increase and diminish, alternately, the capacity of the thorax, will be fully described in taking a review of the skeleton in general.

The ribs of serpents assist in the movements of these animals, and are furnished therefore with respiratory and loco-motive muscles: their ribs move alternately like the feet of the caterpillar.

The *Muscles arising* from the ribs are intercostales, externi et interni, diaphgrama, sterno-hyoidei, sterno-thyroidei, subclavii, pectorales majores et minores, latissimi dorsi, serrati majores antici, cervicales descendentes, obliqui abdominis externi, transversales abdominis.

The *Muscles inserted.* Levatores costarum, intercostales interni et externi, sterno-costales, quadrati lumborum, scaleni antici, medii et postici, serrati postici superiores et inferiores, sacro lumbales, accessorii ad sacro-lumbales, longissimi dorsi, obliqui interni abdominis, and the recti abdominis.

Practical Remarks.

The oblique position of the ribs, and their cartilaginous attachment to the sternum, defend them, in a great measure, from fracture: but some of them are more liable to such an accident than others, particularly the middle ribs, which are neither so much protected by the upper extremity as those situated above, nor so flexible as those below. The ribs are generally fractured near their centre; and the accident may occur either from a blow applied immediately upon the fractured spot, or from the body being forcibly pressed against some unyielding surface, as the ground or a wall. The position of the fractured portions will depend upon the mode in which the force has been applied: if produced by a concentrated force, as by a blow from a hammer, the rib has a tendency to become straightened; the fracture commences internally, and a salient angle is produced inwards, towards the lungs. *(Vide Plate III.)* If, on the contrary, the sternum is forcibly driven inwards, we have the curvature of the ribs increased to such an extent, that the exterior surface of one or more of them gives way, and the salient angle is produced outwards. *(Vide Plate IV.)* The nature of the accident may be ascertained by placing the finger on the suspected rib, near to the spine, and tracing it to the sternum. When you arrive at the fractured point, either the depression or prominence of the bone will be discernible; whilst, at the same time, a crepitus may be felt. Or you may place the whole palm of the hand over the suspected part, and desire the patient to attempt a full inspiration, when a crepitus will also be distinguished.

The treatment consists in passing a broad girth, with a buckle and straps, tightly round the chest, so as to keep the ribs stationary during respiration, which, until union be effected, must be carried on by the diaphragm.

If the salient angle produced have a direction outwards, a compress of wetted linen should be applied over the part fractured: but if, on the contrary, it be directed inwards, two compresses should be forcibly applied at each extremity of the fractured rib, so as to produce a tendency to press outwards the displaced portions, at the seat of fracture.

When the ribs are fractured on both sides of the chest, and opposite to each other, the bandage ought never to be applied. In such a case we must trust to bleeding and the antiphlogistic regimen only.

If emphysema follow fracture of the ribs, pressure may first be tried to prevent the further accumulation of air in the cellular membrane: if this should not avail, small openings ought to be made in the tumour by means of a lancet.

Dislocation of the ribs seems scarcely possible, from the numerous and strong ligaments which connect them with the vertebræ,—unless indeed it be from disease. Mr. Webster, of St. Albans, however, in examining a patient who died of fever, found the seventh rib dislocated, and its head anchylosed on the fore part of the spinal column.

Third Division of the Trunk.

The Pelvis.

(πελυς a basin.)

The pelvis is a cavity of an irregular figure, composed of four bones: the *sacrum* and *os coccygis,* which form its posterior, and the *ossa innominata,* which complete its lateral and anterior boundaries. With respect to its general conformation, it is somewhat in the form of a basin, which is broader from side to side than from before to behind; whilst its perpendicular dimensions preponderate laterally. The sacrum and os coccygis form so perfect a continuation of the spine, that they are nearly as essential to that division of the trunk as to the pelvis itself. I shall therefore first describe them.

The Sacrum,

(Sacer, sacred.)

May be considered as the largest bone of the spine, the weight of which column it receives and transmits to the ossa innominata, with which it is laterally connected.

The form of the bone is triangular, presenting a *base* above, an *apex* below, an *anterior* and *posterior* surface, two *lateral edges,* and a *canal* for the spinal marrow. The *base* of the bone resembles very much, in its appearance, a lumbar vertebra, being furnished with a *body* for its articulation with the last bone of the spine. It has also two projecting *lateral processes* similar to the transverse processes of the vertebræ, and which, like them, give attachment to muscles and ligaments. Its *articulatory processes* are directed backwards and inwards: they are concave, and are connected with the inferior articular processes of the last lumbar vertebra. The *apex* offers below, a small *roughened surface,* by which it is joined to the coccyx; and on each side of this surface is seen a *notch,* which is completed into a foramen by the junction of the two bones.

The *anterior surface* of the bone is concave, smooth, and traversed by *four lines,* which mark the different pieces of which it was originally composed, and impart to it somewhat the appearance of anchylosed vertebræ. It presents *four pairs of foramina,* which communicate with the interior of the bone, and allow of the transmission of the anterior sacral nerves. The fifth pair of foramina are common to this bone and to the os coccygis.

The *posterior surface* is convex and very unequal, presenting in the middle line four or five compressed projecting portions of bone, somewhat resembling diminutive *spinous processes.* These are united, and form one lengthened vertical spine. This spine, however, is not continued the whole length of the bone; but terminates at the upper part of the inferior third of the sacrum, thus below exposing the *sacral canal,* which is of a triangular form, and in the recent subject is closed in by the posterior sacro-coccygeal ligament. The sacral canal is for the purpose of lodging the spinal marrow, and is continuous with that of the lumbar vertebræ. There proceeds from this canal, posteriorly, *four pairs of foramina,* to transmit small nerves from the spinal chord. Upon the posterior surface the notches are seen, which form the fifth pair of foramina by the junction of the os coccygis. These notches are, in this aspect, marked by two projections of bone, which are sometimes called the *cornua* of the sacrum.

The *lateral* or *iliac edges* of this bone present two large *irregular triangular surfaces,* which are connected with corresponding surfaces of the ossa ilia by an intervening cartilage. Below these articular portions the edges are rough, for the attachment of the sacro-sciatic ligaments, and terminate in the small notches which have been described as forming, by their connexion with the coccyx, the inferior sacral foramina.

Connexion.—The sacrum is connected *above,* with the last lumbar vertebra; *laterally,* with the ossa innominata; and *below,* with the os coccygis.

The sacrum is very variable in form in different animals, as well as in the number of its pieces. In the simiæ it is generally composed of but three pieces, but in the ourang outang of four: in these animals its size is comparatively less to the vertebræ than in the human subject.

The cetacea have no pelvis, and consequently no sacrum.

Use.—To form the posterior part of the pelvis, to support the spine, to lodge and protect the spinal marrow, and to give attachment to muscles.

Muscles attached to the sacrum are the m. multifidi spinæ, longissimi et latissimi dorsi, sacro-lumbales, glutei maximi, pyriformes, coccygei, and the obliqui interni abdominis.

Practical Remarks.

In consequence of the deep situation of this bone, and its spongy texture, it is but little liable to fracture: such an accident, however, does now and then occur from the application of some great force, as the passage of a carriage-wheel over the bone, or a fall from a considerable height: and it happens, from the degree of violence necessary to produce the fracture, that it is usually attended with comminution. The muscles attached to this bone do not tend to displace the broken portions; and the dangers and difficulties to contend with, are the injuries inflicted upon the parts within the pelvis, and the tendency there is to suppuration, in consequence of the quantity of loose cellular membrane situated in that cavity. There is generally a great difficulty in forming a correct diagnosis, from the quantity of soft parts which cover the bone: but the leading features pointing out the nature of the accident are paralysis of the lower extremities, the incapacity of the patient to move the pelvis without excessive pain, and a sensation of grating of one bone against another. The treatment consists, first, in passing a catheter into the bladder, lest the urethra or bladder should be injured; and in applying a broad strap around the pelvis, so as to prevent any motion of the bones. Bleeding, low diet, and a strict observance of the horizontal posture are to be carefuly enjoined.

The Os Coccygis,

(*κοκκυξ* a cuckoo.)

Is situated immediately below the sacrum, but does not form a continuous surface, being directed more forwards than the vertical axis of that bone. Like the sacrum, in early age it is divided into four or five small bones, the upper one of which is the largest, but they diminish in size to the fifth: they are all wider than they are long, offering small lateral protuberances, somewhat similar to the transverse processes of the sacrum. The upper portion, or base, presents a middle part, the *body*, which is articulated with the apex of the os sacrum; and two *cornua* laterally, which, passing upwards, convert the notches of the sacrum into the fifth pair of sacral foramina. The fifth bone, if there be one, is small and rounded, having a direction rather upwards as well as forwards. The os coccygis is concave anteriorly, and convex posteriorly: the convex surface being somewhat roughened, for the attachment of the coccygeal ligament; whilst its lateral edges give attachment to the sacro-sciatic ligaments, and to the coccygeal muscles. This bone forms no part of the canal for the spinal marrow.

Connexion.—Only with the sacrum.

The os coccygis in quadrupeds is prolonged by numerous pieces to form the tail. In the simiæ, which have no tails, the coccyx has only three pieces. Galen thus described the human os coccygis, from which circumstance, as well as from any other reasons, it has been deduced that Galen's osteology was not studied from human bones. In the cetacea, the pelvis being wanting, all the bones answering to the os coccygis of other animals, are described as vertebræ.

Use.—To form the posterior and inferior part of the pelvis, and to support the rectum. The sacrum and os coccygis are sometimes termed the false vertebræ; and the great distinction between them and the true vertebræ is, that they do not assist in the motions of the spinal column.

The *muscles* connected with this bone are the m. glutei maximi, coccygei, levatores ani, and sphincter ani.

Practical Remarks.

This bone is less liable to fracture than even the sacrum, for it is equally if not more deeply seated: whilst, from the motion it enjoys, it rather yields to the application of force, than breaks. Fracture, nevertheless, occasionally happens from a fall on the buttock: the nature of the accident is indicated by a severe pain in the coccygeal region, and may be ascertained by examination *per rectum*: the pain is much increased by any attempt to walk, in consequence of the fibres of the gluteus maximus displacing the fractured portions. No kind of apparatus can be applied to assist the re-union of this bone. Rest, poultices, and the antiphlogistic regimen are to be strictly employed, to prevent the occurrence of suppuration; but unless there be some reason for a contrary treatment, the bowels should be kept unrelieved for the few first days, although other antiphlogistic means should be persisted in.

The Ossa Innominata

Are two large irregularly-formed bones, constituting the four part and sides of the pelvis, and the lower part of the abdomen. In the adult, each of them presents an extended surface, inseparable but by violent and arbitrary division: while, on the contrary, during the fœtal period of life, they are each naturally divided into three portions, viz., the *ilium*, *ischium*, and *pubes;* and are connected with each other through the medium of an intervening cartilage, which subsequently becomes permanently ossified. They are also further united in the formation of the acetabulum.

The *os ilium*, or hip-bone, is the largest, and highest in situation of the three bones which form the os innominatum: it derives its name from the small intestine which is contained within its hollow. It is divided into two distinct parts: its thick portion, or *body*, entering into the composition of the acetabulum: and its thin *expanded portion*, forming the lateral boundary of the pelvis. The body forms the anterior and lower portion of the ilium, and presents an *articulatory surface*, which produces rather less than two-fifths of the acetabulum: from this portion of the bone there passes upwards its large expanded surface, which terminates above in a semilunar edge, termed the *crista.* It is roughened, and forms three distinct lines, which are named the *labia*—an *external labium,* giving partly attachment to the m. obliquus abdominis externus: a *middle one,* from which arises the m. obliquus abdominis internus: and an *internal one,* for the origin of the transversalis abdomis. This crista terminates anteriorly and above in the *anterior* and *superior spinous process,* which is the most projecting part of the bone: it gives origin to the m. sartorius, tensor vaginæ femoris, and attachment to Poupart's ligament. About an inch below this, is situated the *anterior* and *inferior spinous process:* it gives attachment to a part of the m. rectus femoris. The crista terminates posteriorly in like manner, in two processes, viz.:—The *posterior* and *superior,* and the *posterior* and *inferior spinous process.* The sacro-iliac ligaments are here attached, uniting the ilium to the sacrum. The expanded portion of this bone presents an external irregularly cenvex surface, termed the *dorsum;* and an internal concave one, denominated the *venter.* Upon the dorsum, asperities are seen, which give attachment to the three glutei muscles. A semilunar line is produced by some of these asperities, extending from the anterior and superior spinous process backwards to the sciatic notch, for the origin of the gluteus minimus. The internal concave surface is divided into two unequal portions by a ridge; anterior to which the bone is regularly concave, for the attachment of the iliac muscle, and has already been denominated the venter: while, posterior to this ridge, is seen a large, irregular, and rough surface, presenting, below, a *beak-like* articulatory process, which, through the medium of an intervening cartilage, connects it with the sacrum: and, above, strong irregularities, for the attachment of those ligaments which strengthen this articulation. From the anterior part of the sacro-iliac symphisis, and passing forwards to where the ilium is connected with the pubes, is a distinct line, termed the *linea ilio-pectinea;* which, when completed by the pubes, forms the line of demarcation between the cavities of the abdomen and pelvis.

The *notches* found upon this bone are two anteriorly, and one large one posteriorly. Those anteriorly, are one between the two anterior spinous processes, which is filled up by the iliac muscle, and is termed, therefore, the *iliac notch:* while the one below the anterior and inferior spinous process, between it and the body of the bone, allows of the passage of both the psoas and iliac muscles out of the pelvis, and may therefore be designated the *ilio-psoal notch.* The posterior notch, the longest of the three, is placed immediately beneath the posterior and inferior spinous process, forming the upper part of the great *ischiatic notch.* Several foramina may be seen on both surfaces of the bone, for the entrance of the nutritious vessels.

Connexion.—The ilium is connected with the ischium and pubes, in forming the acetabulum; and also with the body of the pubes, by the linea ilio-pectinea; with the sacrum, posteriorly, by the sacro-iliac symphisis; and with the head of the thigh-bone, by enarthrosis.

The Os Ischii,

(ισχις the loin.)

Is situated at the lower and lateral part of the pelvis, and is of a very irregular form; but we may distinguish upon it the following parts;—A *body, spinous process, neck, tuberosity,* and *ascending ramus.* The *body* of the bone forms its thickest portion, and is furnished anteriorly with an *articulatory surface,* constituting the lower and back part of the acetabulum, of which cavity it forms rather more than two-fifths. From the posterior part of the body projects inwards the *spinous process,* forming the lower anterior boundary of the upper division of the ischiatic notch, and giving attachment to the anterior sacro-sciatic ligament, the m. geminus superior, levator ani, and coccygeus. Below the body of the bone it is slightly contracted, to form the *neck,* which is rendered more or less smooth, immediately beneath the inferior edge of the acetabulum, by the action of the obturator externus muscle. The anterior edge of the neck and body form a *semilunar sharp ridge,* constituting the posterior boundary of the obturator foramen. Below the neck is situated the *tuberosity,* which is the portion of the pelvis upon which we rest in the sitting posture. This process is rough behind, for the attachment of muscles of the lower extremity. Anteriorly it is hollowed out, to assist the neck in forming the obturator foramen: and internally, immediately beneath the spinous process, is situated a *sulcus,* which allows of the passage of the obturator internus muscle out of the pelvis: and on this region a second *furrow* may be seen extending along the lower margin of the tuberosity towards the ascending ramus, which lodges the internal pudic artery. Extending obliquely upwards and forwards from the tuberosity, is the *ascending ramus* of the *ischium,* which presents two flattened *surfaces* and two *edges.* The anterior edge assists in forming one side of the pubic arch, and the posterior bounds the inferior and anterior portion of the obturator foramen. The internal surface is directed inwards and backwards, to produce a part of the lower circumference of the pelvis; and the external surface is rough, for the attachment of some of the muscles of the hip-joint.

Connexion.—The ischium is joined anteriorly and inferiorly to the pubes by its ascending ramus: to the ilium and pubes within the acetabulum, of which it forms the under and largest part. In conjunction with the pubes, its also forms the obturator foramen.

The Os Pubis,

(βουβων the groin.)

Is the smallest of the three bones which form the os innominatum: it is divided into its *body, horizontal plate, spinous process, symphisis,* and *descending ramus.* The *body* is the thickest part of the bone; and is furnished, at its femoral extremity, with an *articulatory surface,* which forms the anterior and inner one-fifth of the acetabulum: in the formation of which, it is connected above with the ilium, and below with the ischium. At the point of junction with the latter, there is produced a deep sulcus between the two, so as to render the acetabulum much shallower at this point. This notch is situated at the under and fore part of the acetabulum, close to the obturator foramen, and is itself completed into a foramen by the cotyloid ligament. Proceeding inwards from the body, towards the opposite pubes, is situated the *horizontal plate* of the bone, forming a considerable portion of the brim of the pelvis. This plate presents a *posterior* and an *anterior ridge,* with an intervening *flattened surface:* the posterior ridge constitutes that portion of the linea ilio-pectinea which stretches from the junction of this bone with the ilium to the *spinous process,* to assist in the formation of which, it terminates. The pubic fifth of this ridge has Gimbernat's ligament attached to it. The *anterior ridge,* extending from the body to the under part of the spinous process, forms the upper boundary of the obturator foramen, and gives attachment to the m. obturator externus. The *flattened surface* between the two ridges forms a posterior boundary to what is called the crural arch; through which arch, muscles, vessels, and nerves, pass from the pelvis to the thigh. Midway between the anterior and superior spinous process of the ilium, and the symphisis of the pubes, and behind Poupart's ligament, we find, upon the flattened surface just described, a groove or hollow, along which passes the femoral artery: it is at this point that pressure may be effectually made to arrest the flow of blood through that vessel. The *spinous process* already alluded to, is that small projection of bone, produced by the termination of the two ridges of the horizontal plate: it projects rather anteriorly, so as to be readily felt in the living subject. It is of importance to be well acquainted with the situation of this process, as it affords us considerable assistance in discriminating certain varieties of hernia. That rough portion of the bone, extending downwarps from the spinous process of the descending ramus, is termed the *symphisis*, or point of junction between this bone and its fellow on the opposite side. The anterior and posterior surfaces of the bone at this part, give attachment to the ligaments which strengthen this articulation. The *descending ramus* is that portion of the bone which extends from the symphisis downwards, to meet the ascending ramus of the ischium; thus completing the periphery of the obturator foramen: whilst the junction of the ossa pubis and their descending rami, form what is called the arch of the pubes.

Connexion.—The pubes is attached by its body within the acetabulum to the ilium above, and to the ischium below: it is also connected by its descending ramus again with the ischium; and by this junction the foramen obturatorium is formed. The proportions in which the ossa innominata form the acetabulum are as follow:—The ilium rather less than the superior two fifths; the ischium rather more than the inferior and posterior two fifths, which is not only the largest but the deepest part of the acetabulum; and the remaining anterior one fifth is completed by the pubes. It is within this cavity that the three bones composing it are connected with the femur by enarthrosis.

Muscles attached to the Ossa Innominata, arising from the Ossa Ilia.—Obliqui interni abdominis, transversales abdominis, latissimi et longissimi dorsi, sacro lumbales, multifidi spinæ, quadrati lumborum, iliaci interni, glutæi maximi, medii et minimi, tensores vaginæ femoris, sartorii, et recti femoris.

Those *inserted* are the obliqui externi abdominis, and psoæ parvi.

Muscles arising from the Ossa Ischia.—Erectores penis, erectores clitoridis, transversi perinæi, transversi perinæi alteri, levatores ani, coccygei, gemini, obturatores externi et interni, quadrati femoris, tricipites adductores femoris, graciles, bicipites flexorum crurum, simitendinosi, semimembranosi.

Muscles arising from the Ossa Pubes.—Recti abdominis, pyramidales, levatores ani, obturatores externi et interni, pectinei, tricipites adductores femorum, graciles.

Those *inserted* are obliqui externi, interni, et transversales abdominis, and the psoæ parvi.

General description of the Pelvis.

We may now consider the anatomical points, connected with the bones of the pelvis, collectively. When articulated it forms a basin, well calculated to sustain and defend the organs situated within its interior, and at the same time offers extended surfaces for the attachment of numerous muscles and ligaments, which assist in closing its openings, and preventing thereby the displacement of its viscera. To understand the relative position of the separate bones entering into the composition of the pelvis, and their processes, which have been mentioned in the description of each bone, this part should be studied most carefully as a whole. It may be divided, for the purpose of facilitating the description, into four regions: an *anterior*, two *lateral*, and a *posterior region*. In the *anterior* and *inferior region* may be observed externally the rami of the ischia and pubes; diverging, as they descend, towards the tuberosities of the ischia, and leaving a large opening from the pelvis, but which, in the recent subject, is filled up by the deep fascia of the perineum, and the organs of generation. The upper part of this opening is called the arch of the pubes. It is formed by the symphisis pubis, which is visible in the central line. Immediately under the symphisis, and through this arch, the urethra passes. On each side of the symphisis, and extending downwards in the course of the rami of the pubes, is situated the foramen obturatorium, occupied, in the recent subject, by ligamentous tissue: and a little further outwards, on each side, may be observed the cotyloid cavity which receives the round head of the femur.

In each of the *lateral regions* are seen, externally, the dorsum ilii above, and sacro-sciatic notch below: the latter of which is filled up by ligaments, muscles, nerves, and vessels, in the living subject, so as to prevent the protrusion of the pelvic viscera.

In the *posterior* and *superior region*, externally, may be observed the sacrum; its ridge in the centre of its four pairs of foramina; and at the lower part the spinal canal: but the spinal marrow is here protected during life by a firm ligamentous matter which closes the canal, and is termed the sacro coccygeal ligament. The os coccygis is also seen in this region, taking a direction rather forwards.

On viewing the pelvis internally, it will be seen to form two cavities, being bisected by the linea ilio-pectinea. The upper cavity is formed by the base of the sacrum and the expanded surfaces of the ilia; and the lower is bounded, anteriorly, by the ossa pubis; laterally, by the ischia; and posteriorly, by the united sacrum and os coccyx, and by the ischiatic notches.

The pelvis also presents two circumferences; an upper and a lower one. The *upper* one may be traced from where the lumbar vertebra unites with the sacrum, to the anterior and superior spinous processes of the ilia, the circle being completed anteriorly in the recent subject by the abdominal muscles; thus forming the upper or abdominal cavity of the pelvis. The *inferior circumference*, or outlet, is marked by three *eminences*, viz., the tuberosities of the ischia, and the os coccygis; and by three *depressions*, the arch of the pubes in front, and the two ischiatic notches laterally. It is the comparative difference in the distance of these parts from each other, which constitutes the grand distinguishing mark between the male and the female pelvis,—the outlet being much more capacious in the female than in the male. But besides this characteristic of the female pelvis, all its lateral dimensions greatly preponderate: while, in the male, the perpendicular dimensions are most considerable.

The great size of the outlet from the female pelvis, is to facilitate parturition; and in a well-formed skeleton, the following measurements are given:—From the upper part of the arch of the pubes, to the articulation of the os coccygis with the sacrum,—from one ischium to the other,—and also from the pubes to the sacro-iliac symphisis, the distance, in each direction, is four inches; comprising, therefore, a circle, the diameter of which is four inches,—consequently, its circumference is about twelve.

The pelvis of the lower animals, bears but little resemblance to the basin-like form of the pelvis of the human subject. Even in the apes, which most resemble the form of man in their skeletons, the ossa innominata are very much elongated; and in the horse and elephant, the length of the symphisis pubes entirely destroys the basin-like form of the pelvis. In the beaver and kangaroo, the pubes are formed of one bone; and in the ant-eater, they are separated as in birds. In the kangaroo, and other marcipial animals, the os pubis is furnished with two small delicate bones, which pass forwards under the abdomen, to support an abdominal pouch, for the purpose of carrying their young. In the human subject, bony union of the pubic synchondrosis, is of excessively rare occurrence.

Parts formed by the Union of the Bones of the Pelvis.

First:—The *acetabula* or *cotyloid fossæ*. The proportions in which the bones forming the ossa innominata constitute these cavities, as well as their relative position, have already been detailed; but it still remains for me to give some account of their general conformation. Each acetabulum is of considerable depth, to receive the head of the femur: its interior is covered with cartilage, excepting at its inner and lower part, where the ligamentum teres is implanted into the bone itself. The acetabulum has a direction forwards, downwards, and outwards, and its circumference is roughened for the attachment of the capsular ligament: its lip in the recent subject is rendered more prominent, and consequently the cavity itself deeper, by a fibro-cartilaginous tissue, termed the cotyloid ligament, which passes round the cup, and at the interior and under part, where it stretches from the body of the ischium to the pubes, converts the notch formed by these two bones into a foramen. This foramen allows of the transmission of blood-vessels into the interior of the joint, whilst a slight groove leads from this notch to the obturator foramen, shewing the direction of the vessel.

The *foramina obturatoria* are produced by the junction of two of the bones of the pelvis—the ischium and pubes. They are large oval foramina, bounded above, by the horizontal plate of the pubes; below, by the ischium; before, by the rami of the pubes and ischium; and, posteriorly, by the acetabulum. They are filled up by ligament and muscles, leaving only a small opening for the passage of the obturator vessels and nerves.

The *ischiatic notches* are two large irregular apertures, leading from the interior of the pelvis, and are directed backwards and outwards. They are bounded by the ilium above and before; by the ischium in front and below; and posteriorly above, by the lower portion of the sacrum; and beneath, by the os coccygis. In the skeleton, the inferior boundary is wanting; but, in the recent subject, this large notch is divided into two distinct foramina by the sacro-ischiatic ligaments. These foramina serve for the transmission of various vessels, nerves and muscles, which constitute the soft parieties of the cavity of the pelvis.

Practical Remarks.

From the manner in which the bones of the pelvis are covered by the soft parts, they are so protected from external violence as to be seldom fractured: but the accident, when it does occur, is one of great danger, from the attendant injury to the viscera contained within the cavity formed by their union. Fracture of these bones is usually produced by the passage of some very heavy weight over the pelvis or by a fall from a considerable height: and in both of these cases, there is generally such a contusion of the soft parts covering the bones, as greatly to increase the danger. The ossa pubis, and ossa ischia, are so protected by the lower extremities, as to be less liable than the ilia to solution of continuity; but, as may be seen in *Plate V.*, the whole of them may be fractured, and even at the same time. The drawing of this plate was taken from a preparation in the Museum of Guy's Hospital. From the immobility of the broken parts upon each other, the diagnosis in this form of injury, is frequently difficult; but the most ready mode of discovering a fracture of the ilium, is, to place the palm of one hand with considerable force upon the dorsum, and with the other to grasp the

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Plate 5.

Warr lith.

crista of the bone at its upper part; when, on moving it inwards and outwards alternately, an indistinct crepitation may sometimes be felt. Such, however, is the immobility of these bones, and so thickly are they covered with muscle, that even when fractured, we often fail to produce a crepitus. If fracture of the pubes be suspected, press your fingers upon the symphisis, then move the crista as before; when, if a fracture exist, a crepitus may be distinguished: and should the ischium be the supposed seat of injury, one hand is to be pressed firmly against the tuberosity, and the crista of the ilium moved, as in the other cases, to detect the precise point of the separation. If, however, in consequence of the great tumefaction, these examinations should prove unsatisfactory, the inability of the patient to move the pelvis, in the least degree without experiencing considerable pain, will assist us in forming a diagnosis; and the pain, in such cases, is usually described as a grating sensation

In the treatment, the point for consideration is not, as in fractures of bones in general, the means to be employed to keep the bones in apposition; for, as has already been noticed, they have little or no tendency to be displaced—our object must be, to apply such remedies as will obviate the effects of inflammation upon the loose cellular tissue contained within the pelvis. We ought, first of all, to pass a catheter, in order to ascertain whether or not the bladder or urethra have been injured. Should the result of our examination, and, perhaps, the flow of bloody urine, indicate such injury, the instrument ought to be allowed to remain to prevent extravasation. A broad belt should then be tightly applied around the pelvis, and the patient kept strictly in the recumbent posture. The better to secure this horizontal position, under all circumstances, a strong broad girth should be passed under the nates, the extremities of it being fastened to a pulley suspended from the top of the bed, so that the patient may be raised with the least possible effort to himself. Copious and repeated blood-letting should be had recourse to; and such topical remedies, as would be most likely to obviate the disastrous results of continued inflammatory action.

LECTURE IV.

THE BONES OF THE EXTREMITIES.

THE parts of the skeleton which we have hitherto described, are well adapted for maintaining, and protecting the organs essential to life, as those of circulation, respiration, and assimilation; but still, many important functions would remain unperformed without

The Extremities.

The extremities form the third division of the skeleton, and are composed of the *upper* and *lower extremities;* between which there is a considerable resemblance, as well in the number, as in the relation of their several bones.

The *upper* or *thoracic extremities,* are situated at the superior and lateral parts of the chest, being attached to the trunk by the articulation of the clavicle with the sternum; this articulation forming the fulcrum for the motions of the whole extremity. Several bones enter into the composition of the upper extremities, and are divided into those of the *shoulder, arm, fore arm,* and *hand.*

A very cursory survey of the superior extremities, is sufficient to shew how well they are adapted for the purpose of seizing and holding objects, and how ill calculated to support, in any way, the weight of the body.

The Shoulder.

There are two bones which constitute the shoulder:—the *scapula,* a flat bone, situated at the posterior and lateral part of the chest; and the *clavicle,* a small cylindrical bone, placed at the upper and anterior part of the thorax, and extending over the first rib.

The Clavicle.

(Clavis, a key.)

This bone forms the line of separation between the neck and the chest: it is situated between the sternum and the scapula.

On tracing it from the former, to the latter bone, it is found to take a course from within to without, and from below slightly upwards, its scapular, being rather posterior, to its sternal end. In shape it somewhat resembles an italic *S*, projecting from the sternum, and forming a concavity in passing backwards to the scapula.

The clavicle is divided into its *body*, its *sternal* and *scapular extremities*, and its *tubercles*.

The *body* comprises the middle part of the bone, and presents a superior surface, which enlarges as it extends outwards: the sternal half of this surface is rounded and roughened, and gives attachment to the m. sterno-cleido-mastoideus; and the scapular half to the trapezius muscle. The inferior surface is similar in its form and direction: it is hollowed in its middle part, to lodge the subclavius muscle; and it has also a foramen, for the passage of the nutritious vessel. The under surface of the body is placed between two projecting portions of bone termed the *tubercles*, which are situated at the precise point where the extremities of the clavicle are connected with the body. The inner tubercle is for the purpose of giving attachment to a ligament connecting this bone with the first rib; and the outer one, for the ligaments which join the clavicle with the coracoid process of the scapula. The anterior edge of the body is large: convex on its sternal half, where it gives attachment to the pectoralis major muscle; and concave on its outer half, to which is affixed the deltoid muscle. The posterior edge, on the contrary, is concave at its sternal, and convex at its scapular end.

The *sternal extremity* is the thickest part of the bone, and terminates in an articulatory surface, which is directed slightly forwards. This surface is somewhat triangular in form, being larger above than below, and is concave from behind to before. The circumference of this extremity of the bone is rough, for the attachment of ligaments to strengthen its articulation with the sternum. It should, however, be mentioned, that an intervening cartilage separates the clávicle from the sternum.

The *scapular extremity* is inclined backwards and upwards, to be connected to the acromion process of the scapula by a small *articular surface*, which has its long axis from before to behind. This extremity presents a *superior*, and an *inferior, flattened, rough surface*, which give attachment to ligaments connecting the clavicle with the scapula.

The clavicle is wanting in many animals, as in the pachydermata, ruminantia, and solidungula. The quadrumana, and some of the rodentia, are furnished with these bones; while the feræ have only partial ones. It will be found, in fact, that those animals that use their anterior extremities, in climbing, digging, swimming, and flying, are furnished with clavicles; while those which merely use them to support their weight, are without them.

The *use* of the clavicles is to afford, through their articulation with the sternum, a fulcrum for the extensive motions of the upper extremities, and also to prevent the scapulæ from approaching each other, and falling upon the thorax: they also afford attachment to several muscles, and protection to the subclavian vessels.

Muscles attached to the clavicles, are the m. pectoralis major, deltoides, and subclavius, beneath; and the trapezius, sterno-mastoideus, and sterno-hyoideus, above.

Practical Remarks.

There are many circumstances which render the clavicle liable to fracture, such as its length preponderating so much beyond its thickness; it being so little protected by soft parts; and, perhaps, most of all, the manner in which it is placed between the scapula and sternum. From the joint influence of these circumstances, a fall upon the point of the shoulder, by driving the clavicle with great force against the sternum, causes the former bone to give way in its middle part.

In this accident, the diagnostic marks are easy of detection, and invariable in their appearance. The external or scapular portion is that which is always displaced, being drawn downwards by the weight of the extremity to which it is attached, and leaving the inner or sternal portion in its natural situation. *(Vide Plate VI. Fig. 3.)* At first sight it is the inner portion which attracts attention, as it appears to protrude in consequence of the skin being drawn forcibly over its fractured extremity, by the descent of the outer portion of the bone. The patient loses the power of raising the hand on the injured side to the head; and if he attempt it, he can only bend the fore arm, in consequence of the humerus having lost its fulcrum. The injured upper extremity approximates to the chest, whilst the width of the shoulder is lost. Under these circumstances, the surgeon should trace the clavicle along its whole extent, to discover the precise situation and direction of the fracture; and then, by raising and supporting the elbow, the scapula may be brought up to the sternal portion of the fractured bone, and crepitus felt.

Treatment.—Place a large firm pad in the axilla, raise the elbow, so as to elevate the outer portion of the bone to the inner, and keep it in that situation by a short sling. In the next place, wind a long bandage round the chest, including in the folds the whole length of the upper arm of the injured limb; thus, you will keep the elbow close to the side, whilst the pad in the axilla will force the shoulder outwards, and prevent its tendency to fall upon the thorax.

In comminuted fractures of the clavicle, and in cases where the fracture extends with great obliquity, it may happen that the broken portions shall lacerate the skin, and render the fracture compound. It is also possible for the subclavian vessels to be injured. These circumstances would necessarily render the prognosis much less favourable. In simple cases, the bone usually consolidates in a few days.

The Scapula,

(Schipha, Hebrew, shoulder blade.)

This bone is situated at the upper posterior and lateral part of the chest, and together with the clavicle, through the medium of numerous muscles, serves to connect the upper extremity with the trunk. It is of a triangular form, and may be considered as one of the flat bones. This bone reaches from the first to the seventh rib, and is placed with a slight degree of obliquity, so that the inferior angle of the two scapulæ have a tendency to converge. The parts which are to be observed on the scapulæ are the following:—

Three *processes,*—the *acromion*, *coracoid*, and *spine:*— three *costæ,*—a *superior*, *posterior*, and *anterior,*—these terminating in *three angles*, a *superior*, *inferior*, and *anterior:* three *fossæ,*—the *fossa supra-spinata*, *fossa infra-spinata*, and *fossa subscapularis.* Three *notches,*—the *acromial*, *semilunar*, and *coracoidal*, besides the *neck* and the *glenoid cavity.* The *external surface* of the bone is convex, and the *internal* one concave. Having thus named the several parts constituting the scapula, the particular description of each will be more readily understood.

I shall commence with the processes, and first, the *spinous process*, which runs across the dorsum or convex surface of the bone, passing from below upwards, and dividing this surface of the scapula into two unequal fossæ for the attachment of muscles. The spine then becomes broader; and, rising up above the body of the scapula, terminates in the *acromion process*, or extremity of the shoulder, which, overhanging the glenoid cavity, protects the shoulder-joint superiorly and behind. The *acromion* is hollow underneath, to allow of the passage of a muscle, and its extremity is tipped with cartilage to be connected with the clavicle. The *coracoid process* rises upwards from the neck of the scapula, passes forwards and inwards over the glenoid cavity, and assists the acromion in protecting the joint: it, also, gives attachment to muscles and ligaments. The *costæ* form the three sides of the triangle: the *superior* one is the shortest, and forms the base of the triangle. The *posterior costa*, or *base* of the scapula, as it is sometimes called, commences from the posterior termination of the superior costa, and passes downwards to terminate at the inferior angle of the bone: several muscles are attached to this part of the bone. The *anterior costa* is the edge of bone passing from the lower part of the glenoid cavity to the inferior angle, and forms the longest of the sides of the triangle: it gives origin to muscles.

The *angles* are produced at the points of junction of the three costæ. The *anterior* one forms the inferior point of the glenoid cavity, and gives attachment to the tendon of the long head of the triceps muscle. The *posterior angle* is formed by the termination of the superior costa and commencement of the posterior, and has the levator scapulæ muscle inserted into it. The *inferior* is the most acute of the three, and is produced by the termination and junction of the anterior and posterior costæ; the latissimus dorsi passes over it.

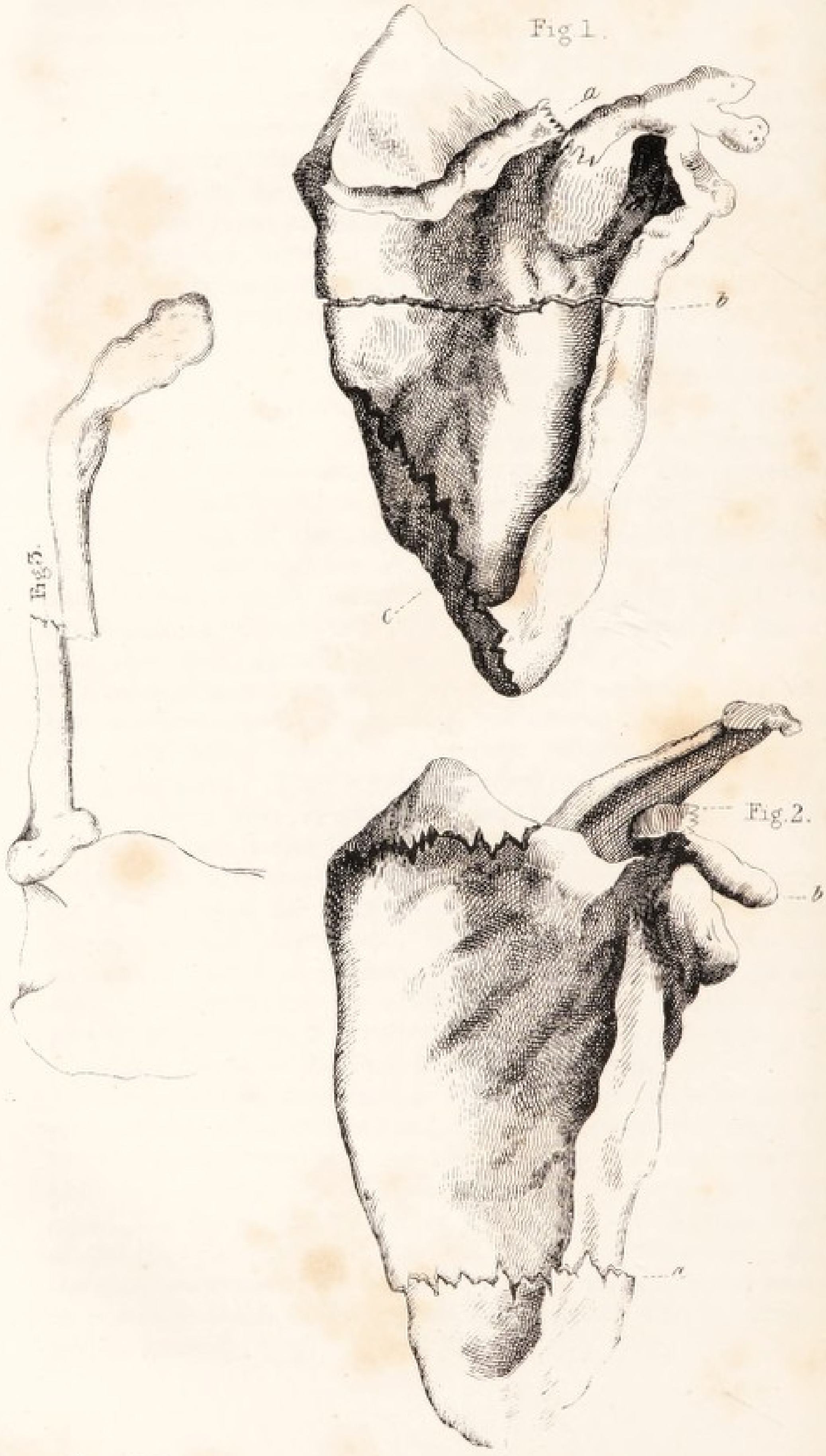
Of the three *fossæ* two are placed on the dorsum of the scapula, whilst the largest one forms the internal concavity of the bone. The *fossa supra-spinata* is all that hollow above the spinous process, between it and the superior costa, and lodges the supra-spinatus muscle. The *fossa infra-spinata* forms the remaining portion of the dorsum of the bone below the spine, and lodges the infra-spinatus muscle; while the whole of the cavity on the inner side or venter of the scapula constitutes the *fossa subscapularis*, so named from the muscle which arises from it. Two of the notches have reference to the fossæ—the *acromial* and *coracoidal*. The *acromial notch*, situated between the junction of the two fossæ spinatæ and neck of the glenoid cavity, receives the tendons of the two spinati muscles in their passage to the humerus; whilst the *coracoidal notch* is that extreme point of the fossa subscapularis, placed between the base of the coracoid process and edge of the glenoid cavity.

The *semilunar*, or proper notch of the scapula, is situated between the superior costa and root of the coracoid process; the notch being formed in the recent subject into a foramen, by a ligament. The superior dorsal artery of the scapula passes above this ligament, whilst its corresponding nerve passes beneath it and through the foramen.

The anterior costa is surrounded by an articulatory surface, which is termed the *glenoid* cavity. It is of an oval form, superficial, and larger below than above. Its great diameter is vertical, and it is slightly inclined outwards. The glenoid cavity is surrounded by a fibro-cartilaginous structure in the recent subject, which renders it deeper; and the upper part gives attachment to the long head of the biceps.

This cavity is connected with the body of the scapula by a contracted portion of the bone, which is termed the *neck*. It is to be remembered that the true neck is only that portion of bone between the glenoid cavity and base of the coracoid process; it is the portion which is roughened for the attachment of the capsular ligament, and not, as is sometimes described, the part posterior to the coracoid process, including the proper or posterior notch. The scapula is connected with the sternum and os humeri.

Page [illegible]. Plate 6.



Warr lith.

The form of the scapula is very different in different animals, and is found developed in the direction parallel to the spine, in proportion to the speed of the animal or the violent efforts it makes with its anterior extremities.

The *use* of the scapula is, with the assistance of the clavicle, to serve as a fulcrum for the upper extremity; and, from its extent of motion, to present under every direction of the arm, a convenient socket for the head of the os humeri to move in. The scapula also defends the posterior part of the thorax and its contents from external injury.

Muscles attached to the scapula are seventeen in number. Of these six are inserted into the scapula, and eleven arise from it. Those *inserted* into it are m. levator scapulæ, into the superior angle; rhomboideus major, minor, and serratus anticus, into the whole length of its base or posterior costa: pectoralis minor into the coracoid process: and, lastly, the trapezius into the acromion and spinous processes. The eleven *arising* from it are, first, the m. omo hyoideus, from the superior costa close to the notch; from the under part of the spine and acromion process, the deltoides; from the three fossæ, the supra and infra spinati, and the subscapularis; the teretes and long head of the triceps, from the anterior costa: the coraco-brachialis and short head of the biceps, from the coracoid process, the long head of the biceps from the apex or upper part of the glenoid cavity; and, lastly, the latissimus dorsi, in its passage over the inferior angle of the scapula, derives a small part of its origin from that portion of the bone.

Practical Remarks.

The scapula is a bone but little liable to fracture, equally from its situation as from its mobility. Nevertheless, under particular application of force, fracture of this bone is occasionally met with; and more particularly in certain parts of it, from their greater comparative exposure: as, for instance, the acromion, inferior angle, superior angle, and coracoid process. Fractures, either longitudinal or transverse, may also happen through the dorsum of the bone. Fracture of the acromion may be readily discovered, as the fractured portions are much displaced by the action of muscles. In this accident the roundness of the shoulder is lost, by the weight of the upper extremity and the action of the deltoid muscle drawing the point of the acromion downwards; while the trapezius and levator scapulæ, have a tendency to draw the scapula, and the remaining portion of the acromion, upwards and slightly backwards. The position of the two fractured portions may be seen in *Fig.* 1. *Plate VI.* When the inferior angle of the scapula is separated from the rest of the bone, the deformity which occurs renders the nature of the accident sufficiently obvious to be easily detected. The detached portion is drawn forwards by the inferior fibres of the serratus major anticus, and by the teres major, while the rest of the bone remains in its natural position: but the most conclusive diagnostic mark of this accident is, that, if the scapula be moved, the detached angle remains perfectly stationary. *(Vide a. Fig. 2. Plate VI.)* If the coracoid process be broken off, its extremity is drawn downwards by the coraco-brachialis and biceps muscles, and forwards by the pectoralis minor. The position of a fractured coracoid process is shewn in *Plate VI. Fig. 2. b.* In the transverse fractures through the dorsum scapulæ, there is also slight derangement of parts. If the fracture extend completely across the bone, the displacement is produced by the action of the serratus major anticus, which being strongest at its lower part, draws the inferior portion of the scapula forwards: so that by passing the finger along the posterior costa, an irregularity of surface may be felt. *(Vide Plate VI. Fig. 1. b.)* When fractures through the dorsum are vertical in their direction, but very slight derangement occurs, in consequence of both the external and internal surfaces of the scapula being so completely covered by muscles. *(Vide Plate VI. Fig. 1. c.)* In all cases of fracture of the scapula, great attention should be paid to the constitutional as well as to the local treatment, as the principal danger arises from the contusion of the soft parts necessarily attendant on a degree of violence sufficient to produce the fracture. Bleeding, purging, and the antiphlogistic regimen are to be strictly adhered to, to prevent the inflammation terminating in abscess, and, probably, subsequent exfoliation of bone. When the dorsum of the bone is fractured, the arm ought to be fixed to the side of the thorax by a long roller passed round the chest, enclosing the arm from the shoulder to the elbow, much in the same manner as the bandage directed to be applied in fracture of the ribs. But when the fracture is at the inferior angle, the arm is to be drawn across the fore part of the chest, and confined there, so as to bring the scapula towards the detached angle, which is itself too small to be acted upon.

In fractures of the acromion, the head of the humerus is to be forced upwards, and retained there so as to form a splint to the acromion. This may be accomplished by applying a bandage round the trunk and arm, and afterwards carrying it from the elbow to the shoulder for several turns, till it produces an effect similar to that of a short sling. This bandage must be worn for six weeks at least, as the acromion requires a considerable time for its consolidation. Lastly, in fractured coracoid process, the object is to relax the fibres of the coraco-brachialis biceps, and pectoralis minor; which is to be done by bringing the humerus forward, the scapula inwards, and bending the fore arm to a right angle, and fixing the whole in this position by bandages.

The Os Humeri,

(ωμος the shoulder.)

The *humerus* is the largest bone of the upper extremity, situated between the scapula above, and the radius and ulna below. It is cylindrical in form, and is divided into its *body* and two *extremities.*

The upper *extremity* or *head* of the bone presents an articulatory surface, which forms about the third part of a sphere, and is directed upwards, backwards, and inwards, towards the glenoid cavity of the scapula, with which it is connected by ligaments, to form the shoulder-joint. Immediately around this articulatory surface, the bone is *rough*, for the attachment of the capsular ligament; and it is this point joining the head of the bone to the body, or shaft, which is to be considered the true anatomical *neck*. Just below the neck, on the upper anterior and outer part of the body of the humerus, is situated the *greater tubercle*, which is furnished with an outer, middle, and internal surface, for the attachment of three of the muscles of the shoulder-joint. To the inner side of this process we observe the *lesser tubercle*, and which gives attachment to one muscle only. Between these two tubercles there is a deep *sulcus*, or *groove*, which is lined with cartilage, and receives the tendon of the long head of the biceps. This groove necessarily possesses two *edges*, both of which are rough, for the insertion of muscle. The *body*, or *shaft*, extends from the head of the humerus to its condyles, and forms by far the greatest part of the length of the bone; if divided into thirds, the upper third is rounded, the middle twisted, and the lower one flattened. It may also be observed, that the upper third is smooth posteriorly, allowing the triceps muscle to pass over it, which is not attached to it; while anteriorly on this portion of the bone, two lines may be seen proceeding from the outer and inner tubercles, to terminate at the condyles. The groove for lodging the tendon of the biceps, is also situated on this part of the bone. The middle third presents a contorted appearance, as if the head of the bone and the condyles had been twisted in opposite directions half round, so as to produce this singular effect. Two *rough surfaces* are seen on this portion of the bone for the attachment of muscle: an *outer* one for the insertion of the deltoid, and an *inner* one for the insertion of the coraco-brachialis. A *foramen* for the nutritious artery is also found in this region, the direction of which is from above to below. The lower third of the humerus is flattened, and increases in breadth as it descends to terminate in the condyles. It offers an *anterior* and a *posterior* flattened surface, and two *lateral ridges*. The anterior surface is somewhat roughened for the attachment of the brachialis internus muscle, and presents, immediately above the internal condyle, rather to the inner side of the centre of the bone, a deep *depression*, to receive the coronoid process of the ulna during a flexed state of the fore arm. This depression is sufficiently deep to allow flexion of the arm to a very acute angle. The *posterior surface* is smooth, allowing the passage of the triceps muscle over it, but not giving origin to it; and, at the lower part, immediately above the condyles, in the middle line of the bone, is situated a *deep depression*, which lodges the olecranon process of the ulna, during extension. The olecranon is so large and projecting, as not to allow extension beyond the straight line. The lateral ridges are continuations of the two lines leading from the greater and lesser tubercles above, and which were before described as terminating at the condyles. They are for the purpose of giving attachment to muscles of the elbow and wrist-joints. The inferior extremity forms the external and internal *condyles*, the former giving origin to the extensor, and the latter to the flexor muscles of the hand and fingers. The external condyle presents below a *rounded articulatory* *surface*, well adapted to allow of the two-fold motions of the radius: namely, the flexion of the elbow-joint, and the revolution of the radius upon the ulna. Just on the outer side of this surface is a small projecting *non-articular apophisis*, which gives attachment to muscles and ligaments. The internal condyle is larger, and very different in its form. Like the external, it is covered with cartilage, and presents a *pulley-like articulatory surface*, which is called the *trochlea*, on which the sigmoid cavity of the ulna moves in flexion and extension. Both the condyles present a larger articulatory surface anteriorly than posteriorly, which admits of a greater extent of flexion than of extension of the fore arm. The internal condyle is also furnished with a non-articular apophisis on its inner side, which is much more projecting than the outer one, but serves a similar purpose in giving attachment to muscles and ligaments.

The os humeri is *connected* above with the scapula, and below with the radius and ulna, entering into the composition of the shoulder and elbow-joints: indeed, it may be considered to assist also in forming the superior radio-ulnar articulation, as none of the motions of that joint can take place without the radius rolling on the external condyle.

In all mammalia, the humerus is a single bone, and comparatively varies but little in its form; but it may be remarked, that it is always short in proportion to the length of the metacarpus. In those animals that have great speed, as the horse, deer, &c., the metacarpal bone is very lengthened, is termed the cannon bone, and the humerus runs so parallel with the ribs, as to be concealed under the muscles of the thorax.

The *muscles* attached to the humerus, are those of the shoulder-joint, which are inserted into it, and several of the muscles of the elbow, wrist, and fingers, which have their origin from it, amounting in all, to twenty-four. Beginning at the upper extremity of the bone, there are inserted into the greater tubercle three muscles, viz. the m. supra-spinatus, infra-spinatus, and teres minor: into the lesser tubercle, one only, the subscapularis. Into the edges of the bicipital groove, three muscles; one, the pectoralis major, into the outer or anterior edge, and two into the inner edge, viz. the latissimus dorsi, and teres major. The whole of the posterior part of the bone is covered by the triceps muscle, and two of its heads arise from the humerus itself: the second begins to be attached immediately below the outer and back part of the greater tubercle, extending downwards in connexion with the line reaching from that process to the external condyle. The third head arises just where the internal ridge of the bicipital groove is lost in the substance of the bone. About the middle of the bone, on its outer side, is inserted the deltoid muscle, and just to the inner side of this, the coraco-brachialis. The junction of the middle with the lower third of the bone anteriorly gives origin to the brachialis internus. The internal condyle gives origin to the pronator radii teres of the radio-ulnar articulations, to the flexor carpi radialis, palmaris longus and flexor carpi ulnaris of

Plate 7.

Fig. 2

Fig. 3.

Fig. 1.

arr lith.

the wrist-joint, and to the flexor sublimis perforatus and flexor longus pollicis, muscles of the fingers. The external condyle has arising from it the m. anconeus of the elbow-joint, the supinator radii longus and brevis of the radio-ulnar articulations, the extensor carpi radialis longior and brevior, and the extensor carpi ulnaris of the wrist-joint; and, lastly, the extensor digitorum communis of the fingers.

Practical Remarks.

The humerus may be fractured in any part of its length; but in consequence of the diversified actions of the muscles attached to it, the position of the displaced portions of the bone will vary according to the situation of the fracture. It therefore becomes highly important to consider each fracture separately. The humerus may be fractured through its neck, within the capsular ligament: it may be fractured just below its tubercles, above the insertion of the pectoralis major, latissimus dorsi, and teres major: or in the space between those muscles, and the insertion of the deltoid: or below the deltoid muscle: or, lastly, through the condyles of the bone.

When the fracture is through the neck, and consequently above the tubercle of the bone,—an accident, however, of rare occurrence,—but little deformity takes place; the bone being retained in nearly its natural situation by the capsular ligament. The shaft of the bone is nevertheless drawn slightly upwards and outwards; the rotundity of the shoulder remains, and crepitus may be readily felt in consequence of the proximity of the fractured surfaces: for the capsular ligament not being torn, little separation can take place. (*Vide Plate VII. Fig.* 1.) The treatment proper for the accident is, to confine the arm in a short sling, to place a pad in the axilla, and to apply pressure on the greater tubercle by means of a compress and bandage, so adjusted as to press the upper extremity of the shaft against the head of the bone, which remains in its natural position within the glenoid cavity.

The injury next to be described has, by some surgeons, been called fracture of the *neck* of the bone. The situation alluded to, however, is immediately below the tubercles of the os humeri, above the insertion of the muscles attached to the edges of the bicipital groove, which cannot certainly with propriety, be regarded as the *anatomical* neck of the bone. I would designate the accident, therefore, *fracture immediately below the tubercles.* At first sight, the position of the arm might lead the surgeon to suppose, that the deformity depended upon a dislocation of the head of the bone into the axilla; but attention to the following circumstances will generally enable us to form a correct diagnosis. The roundness of the point of the shoulder remains: a hollow is observed below the point, in consequence of the lower fractured portion, or shaft, being drawn inwards by the action of the pectoralis major, latissimus dorsi, and teres major whilst the deformity is increased by the action of the teres minor and spinati muscles drawing the upper portion of the fractured bone upwards, outwards, and backwards: no tumour is to be felt in the axilla: the whole limb is moveable, so that a very slight force readily restores it to its natural position; but this force is no sooner withdrawn, than the deformity returns: lastly, the patient experiences the same difficulty in raising the hand to the head, as occurs in fracture of the clavicle, a difficulty in both cases arising from a loss of the fulcrum, upon which the upper extremity plays. The treatment is much the same as in fracture of the clavicle. A large conical pad should be placed, with its base upwards, in the axilla, and the arm confined to the chest by a bandage, including the extremity from the shoulder to the elbow. Four splints ought also to be applied to the arm, in order to prevent displacement by the action of the muscles. *(Vide Fig. 2. Plate VII.)*

When the fracture occurs in the space between the insertion of the latissimus dorsi, pectoralis major, and teres major, and the attachment of the deltoid muscle, the position of the fractured portion is very different from that accident last described. In this case, the lower part of the bone is drawn upwards and outwards by the action of the deltoid, so as to form a perceptible tumour on the outer side of the arm; and the deformity is increased, if the fracture be oblique, by the action of the pectoralis major and latissimus dorsi, which draw the upper portion of the bone inwards. (*Vide b. Fig. 3. Plate VII.*)

Extension and counter-extension having been made to adapt the fractured surfaces, they are to be retained in apposition by splints and bandages, and by confining the arm close to the trunk, so as to relax those muscles which have a tendency to displace the fractured surfaces of the bone.

If the humerus be broken below the deltoid muscle, at the flat portion of the bone, but little deformity follows, in consequence of the extent of attachment of the brachialis muscle on the fore part, and the triceps behind, which, by their combined action serve as a kind of splint to the bone. (*Vide c. Fig. 3. Plate VII.*) Nevertheless, should the bone, even in this situation, be broken with great obliquity, a greater degree of displacement occurs that when the fracture is transverse: bnt in both cases, the lower fractured portion of bone is drawn slightly forward. This accident is often mistaken for dislocation of the radius and ulna, in consequence of the deformity being nearly the same in both; but the diagnosis is rendered clear, by making extension, when all the signs of dislocation immediately disappear. The treatment in this accident is to bend the fore-arm to a right angle, and to maintain it in that situation by pasteboard splints; at the same time keeping the elbow-joint constantly moistened with evaporating lotions.

The condyles of the humerus are sometimes separated from the rest of the bone: this accident most frequently happens to the internal condyle, from its great projection of tubercle, and the little protection afforded it by soft parts. (*Vide d. Fig. 3. Plate VII.*) It usually occurs at an early age. Form the condyle being drawn backwards, it appears as if the ulna were the bone displaced: but the nature of the injury may be distinguished, by the ulna resuming its natural situation on extension being made, and also by crepitus, which is very readily detected. The treatment consists in applying a roller around the joints, in bending the fore arm, and maintaining the broken portion of the bone in its natural situation, by means of wetted pasteboards. Passive motion should be employed, after the lapse of three weeks, to counteract any disposition to anchylosis.

When the external condyle is fractured, swelling, inability to perform the motions of the elbow-joint, and crepitus, are the diagnostic marks. Here the crepitus is most perceptible when the patient is desired to attempt the rotatory motions of the hand. When a large portion of the condyle is broken off, it is drawn somewhat upwards and backwards. The treatment is the same as in fracture of the internal condyle. Pasteboard splints best answer the purpose in these accidents.

The Fore-Arm

Forms the third division of the superior extremity, and is composed of two bones, the radius and the ulna.

The Radius.

(ῥαβδος a spoke.)

The *radius* is shorter than the ulna by a length equal to that of the olecranon; it is placed on the outer side of the arm, is continued on the same line with the humerus, and reaches from the elbow to the wrist-joint. It is of a cylindrical form, and is divided into a *body, neck, tubercle,* and *two extremities.* The *upper extremity,* or *head,* presents a rounded cup-formed articulatory surface, which is covered with cartilage, and receives the external condyle of the humerus, thus entering into the composition of the elbow-joint. This cavity is surrounded by a projecting lip of bone, which presents upon its inner side a cartilaginous surface, having its long axis and convexity from before to behind, and is received into the smaller sigmoid cavity of the ulna, thereby producing the superior radio-ulnar articulation. Immediately below the head, the bone becomes contracted, forming the *neck,* which is rounded and smooth, to allow the bone to move readily within the coronary ligament. Just below the neck, on the inner and fore part of the bone, is placed the *tubercle,* a projecting rough surface of bone, for the tendinous insertion of the biceps muscle. Below this process is the *body,* which extends to the lower extremity, and forms the greatest part of the length of the bone. It is of a triangular form, and presents *three surfaces,* and *three angles.* The *anterior surface* is somewhat hollow above, expanding in its lateral dimensions as it descends, and becoming flattened for the attachment of the pronator quadratus muscle. On this surface is to be observed the *foramen* for the nutritious artery, having its course from below upwards. The *posterior surface* presents a convexity outwards and a concavity inwards, which are more particularly distinct in the middle third of the bone. The concavity offers an extended surface for the attachment of the muscles of the thumb. The lower third of this surface, is grooved for the passage of the tendons which are attached to the fingers. The *external surface* is arched, and offers nothing remarkable, excepting a *rough surface* in its centre, for the insertion of the pronator radii teres muscles. Of the *angles,* the *internal* is the most acute, and gives attachment to the interosseous ligament: it forms a very considerable arch, the concavity of which faces inwards, thereby producing a space between it and the ulna for the lodgement of muscles. The *external* angle is rounded, presenting no particular point worthy of observation. The *posterior angle* is only to be remarked in the lower two-thirds of the bone, and forms a ridge between the posterior superficial and deep layer of muscles.

The *inferior extremity* of the radius is the largest part of the bone, and is divided into an *anterior* and a *posterior surface*, two *articulatory surfaces*, and a *non-articular process*. The anterior surface of the inferior extremity is concave from side to side, allowing of the passage of the flexor tendons to the fingers. The posterior surface forms a general convexity from side to side, but is rendered irregular by four grooves, which pass from above to below, and which admit of the passage of the following tendons: the outer groove receives the tendons of m. primi et secundi internodii; the second groove, the extensor carpi radialis longior et brevior; the third, the extensor tertii internodii; while the fourth and inner one, transmits the tendons of the indicator and extensor digitorum communis. On the outer side of the inferior extremity of the radius, between the first and second described grooves, is situated the process which is termed the *styloid*, and which gives attachment to the external lateral ligament of the wrist-joint. On the inner side an *articulatory surface* is found, with a concavity passing from before to behind, which serves to receive the lower extremity of the ulna; it is termed the *smaller scaphoid cavity* of the radius. The inferior extremity of the radius forms the larger *articulatory surface*, which has its long axis from side to side, its concavity from before to behind, and is called the *greater scaphoid cavity*. It is covered with cartilage, and divided into two unequal portions by a *ridge*, which passes from before backwards. The outer part articulates with the os scaphoides, and the inner with the lunar bone, for the formation of the wrist-joint.

The radius is *connected* above, with the humerus; below, with the scaphoid and lunar bones; and on its inner side, by a double articulation, with the ulna.

Muscles attached to the radius are eight: four of which, employed in the radio-ulnar articulation, are inserted into that bone, viz., the m. supinator radii longus and brevis, pronator radii teres, and pronator quadratus, and one muscle of the elbow-joint, the biceps: whilst the three which arise from it are muscles of the fingers, viz., the flexor sublimis digitorum, flexor longus pollicis, and extensor primi internodii.

The Ulna.

(ωλενη the cubit.)

This is the longer of the two bones of the fore-arm: it is situated on the inner side, is larger above than it is below, and is divided, like the radius, into a *body* and *two extremities*.

The *superior*, or *humeral extremity*, which is the largest part of the bone, is very irregular in its form, and composed principally of two *large processes*, and two *articulatory surfaces.* The larger of the processes is termed the *olecranon*, or *head of the ulna:* it forms the superior and posterior portion of the bone, and gives to it the length which it possesses beyond the radius. This process is rough above, for the attachment of the triceps muscle. Behind it forms a triangular surface, which is merely covered with skin, and may be easily felt in the living subject. Anteriorly, it is concave, covered with cartilage, and forms a portion of the articulatory cavity which receives the internal condyle of the humerus. The smaller anterior process is termed the *coronoid:* it is situated below as well as before the olecranon, and is directed from the upper part of the ulna forwards, and slightly upwards. It posterior surface is concave, and, in the recent subject, covered with a cartilage continuous with that lining the olecranon; thus, together, completing the *greater sigmoid cavity*, which receives the trochlea of the humerus. This cavity is divided by a ridge, passing from the upper part of the olecranon, to the top of the coronoid process, into two unequal portions, the inner of which is the larger. Immediately on the outer edge of the coronoid process is found the *smaller sigmoid cavity*, which is hollowed from before to behind, and receives the inner articular surface of the head of the radius. The inner edge of the coronoid process is sharp, and roughened, for the attachment of muscles and ligaments; while, anteriorly and below, it turbinates in a roughened *tubercle*, to which is attached the tendon of the brachialis internus muscle. The *body* of the ulna is triangular, and presents an *anterior*, a *posterior*, and an *internal surface:* also an *external*, an *anterior*, and a *posterior angle.*

The *anterior surface* is concave throughout its whole length, to lodge the numerous muscles situated between it and the radius. The lower part of this surface is somewhat flattened and rough, for the origin of the m. pronator quadratus. In its upper third may be seen the nutritious foramen, which takes its course from below upwards. The *posterior surface* is divided by a line which passes from the posterior edge of the smaller sigmoid cavity through the whole length of the bone, and gives insertion to some of the muscles of the elbow-joint, and origin to those of the fingers. The *internal surface* is broad and concave above, where it is covered by muscles; while the lower third becomes contracted, and is placed immediately under the skin, where it may be readily distinguished in the living subject. Of the three *angles*, which separate the described surfaces from each other, the *external* is the most projecting, especially in its middle part, and gives attachment to the interosseous ligament. The *anterior angle* is more obtuse, and particularly so above, where it gives attachment to the deep flexor muscle common to the fingers; while below it is sharper, for the origin of the pronator quadratus. The *posterior angle* commences immediately below the triangular surface of the olecranon: it is at first very marked, but below it is lost imperceptibly in the substance of the bone, which there becomes rounded. Above, it gives attachment to the intermuscular tendon, which affords a common origin to the flexor and extensor carpi ulnaris, and the flexor profundus digitorum muscles.

The *inferior* or *carpal extremity* of the ulna, is much smaller than the superior; is rounded in form, but rendered irregular on its inner side by a projecting conical apophisis, which is termed the *styloid process*, the extremity of which gives attachment to the internal lateral ligament of the radio carpal articulation.

The outer part of the inferior extremity is round, and is named the *head* of the ulna: inferiorly, it is covered with cartilage, where it is contiguous with the interarticular cartilage of the wrist-joint, which separates it from the cuneiform bone. Externally, it also forms an articular surface to be connected with the radius, forming the inferior radio ulnar articulation. Anteriorly, the head of the ulna is rough, for the attachment of ligament. Posteriorly, a deep groove separates the styloid process from its inferior articulatory extremity, for the passage of the tendon of the extensor carpi ulnaris muscle.

In the simiæ the form of the fore-arm is very similar to that of the human species. In the carnivora the olecranon is compressed, and is extended further backwards than in man. In the pachydermata the radius and ulna are distinct, but no rotation is performed between them: in the ruminantia they are anchylosed. In the elephant the inferior part of the ulna is larger than that of the radius. In the horse the ulna does not extend to the wrist, but terminates in a slender point, and is connected by ligament to the radius, requently, however, becoming anchylosed.

Use.—The ulna is articulated with the humerus, these two bones nearly completing the elbow-joint: the radius having but little office in the functions of that articulation. It is also connected above with the radius, which it receives in forming the superior radio-ulnar articulation: and below, it forms the inferior radio-ulnar articulation, by being received by the radius. It has no connexion with the wrist-joint, being separated from it by the upper surface of the interarticular cartilage.

Attachment of Muscles.—Fifteen muscles are attached to the ulna. Three of the elbow-joint are inserted into it:—the brachialis internus,


Fig 1.
Fig 2.
Fig 3.
a
b
a
a
b

the anconeus, and the triceps. Of the radia-ulnar articulations, three muscles arise from the ulna :—the m. supinator radii brevis, the m. pronator radii teres, and the m. pronator quadratus. Of the wrist-joint, the muscles arising from the ulna are—the m. flexor carpi ulnaris and radialis, and the extensor carpi ulnaris. Of the fingers, the m. flexor communis sublimis, et profundus digitorum, extensor primi, secundi et tertii, internodii pollicis, and indicator.

Practical Remarks.

Fractures of the Fore-Arm.—Of the two bones, the radius is much more frequently broken, in consequence of its being attached to the hand, and placed in a direct line with the humerus; from which circumstance, in a fall, the hand being naturally put forward, the whole weight of the body is communicated to the radius, this bone is driven forcibly against the humerus, and not unfrequently gives way at its middle part. Pain, a loss of power in effecting the motions of pronation and supination of the hand, and a crepitus which may be readily felt in producing those rotatory motions, form the diagnostic marks of the nature of the accident. Under these circumstances, the position of the fractured portions is such as to form a salient angle inwards, towards the ulna—a disposition of parts produced by the action of the pronator muscles: *(Vide a. Fig.* 1., *Plate VIII.)* and therefore rendering the space between the two bones of the fore-arm much less, and projecting the muscles from between them. When the radius is fractured through its neck, the diagnosis is more difficult, in consequence of the thick covering this part of the bone receives from numerous muscles; and the nature of the accident is further obscured by the difficulty in producing crepitus. The obscurity occurs from the position of the fractured portions of the bone, the inferior being drawn upwards, inwards, and forwards, by the action of the biceps muscle, while the head and fractured neck of the bone, are drawn slightly outwards by the supinator radii brevis. (*Vide b. Fig* 1., *Plate VIII.*)

In fractures of the radius, the hand is constantly proned.

Fractures of the Ulna.—The ulna is less liable to fracture than the radius, from circumstances already mentioned. The accident usually occurs from the application of a force applied immediately upon the fractured part, and most frequently at its lower extremity, in consequence of the bone there being smaller and less defended by soft parts. By passing the fingers along the internal surface of the bone, an irregularity will be felt at the point of fracture, in consequence of the lower portion of the fractured bone being drawn outwards, towards the radius, by the pronator quadratus muscle. (*Vide a. Fig.* 2., *Plate VIII.*) The superior portion of the ulna remains fixed.

Fractures of the Olecranon.—Occasionally the olecranon is separated from the ulna, and it is said sometimes to occur from the inordinate action of the triceps muscle; but it must more frequently happen from a fall upon the point of the elbow. When this accident occurs, the olecranon is drawn upwards above the condyles of the humerus, by the action of the triceps muscle, so that a hollow is found at the posterior part of the elbow-joint, instead of the prominence which this process forms when in its natural position. The degree of separation of the fractured olecranon from the ulna, being increased and diminished by flexion and extension of the elbow-joint, is a further diagnostic mark, and renders the nature of the accident sufficiently obvious. However, when the fracture has occurred from any great degree of violence, the contusion and swelling may render the diagnosis more difficult. But these concomitant circumstances should not perplex the surgeon, as the treatment should be immediately directed against the inflammation, as if the fracture did not exist, until it be sufficiently subdued to discover the extent of injury.

The treatment to be followed in fracture of the olecranon, (of which I shall now treat, as it differs from that followed in all the other accideents to the bones of the fore-arm), consists in placing the fore-arm in a perfectly extended position; and by gradually drawing down the triceps muscle, the fractured olecranon may be brought into contact with the upper part of the ulna: it may be retained in this situation by a stellate bandage passing above and below the elbow, and should be continued along the whole length of the humerus, which diminishes the irritability of the muscles by affording them a general support The anterior hollow of the elbow should be filled with lint, and a long splint should be applied over it, to maintain the extended position of the limb, which is essential to the reparation of the bone.

Fracture of both Bones of the Fore-Arm.—When this accident happens, it usually occurs either from a heavy weight passing over the arm, or from a violent blow; and in either case the bones are usually fractured on the same level. A fall can hardly produce fracture of both bones at once, as the radius receives the whole weight of the body.

The diagnosis in this accident may be formed from the following indications:—pain, loss of motion, particularly as to pronation and supination of the hand, and by a crepitus being perceptible in producing rotatory motion. The arm has also a rounded appearance, as if tumefied, in consequence of the protrusion of the muscles from the interosseous space. In this accident there is but very little shortening of the limb.

Treatment.—Place the hand between supination and pronation, and slightly directed towards the ulna; semiflex the fore-arm, and then, while making gentle extension and counter-extension, push back the protruded muscles between the bones, keeping them in that situation by placing a well adjusted pad on the fore and back part of the arm, reaching from the elbow to the wrist: over these apply splints, which are to be retained by three or four pieces of tape—not a bandage, as it would tend to thrust the broken bones towards each other, and again diminish the interosseous space. Then place the fore-arm in a sling, and allow the hand to hang down, so that a constant extension of the limb may be kept up, which very materially assists in retaining the fractured ends of the bones in their proper situation. The principal point is to preserve the natural extent of the interosseous space; for if this be diminished, the rotatory motion of the radius must be imperfect. The treatment, when only one of the bones is broken, differs in no respect from that recommended for fractures of both bones; excepting, perhaps, it may be considered worthy of notice, that in fracture of the lower part of the radius, the hand should be bent more inwards towards the ulna, and permanently retained in that position during the progress of cure.

The Hand.

The bones of the *hand* form the last division of the upper extremity, and correspond all the parts from the joint of the wrist to the points of the fingers. It presents a convexity posteriorly, to give strength, and a concavity before, for the purpose of enabling it to grasp substances. The hand is capable of a considerable extent of motion, in flexion and extension, but of a slight degree in a lateral direction.

The bones of the hand are subdivided into those of the *carpus*, *metacarpus*, and *phalanges*.

The Carpus.

(Carpo, to seize, or καρπος a seed.)

The superior part of the hand is formed of eight small bones, disposed in two rows, each consisting of four: the upper called the *cubital row*, consisting of the *scaphoid*, *lunar*, *cuneiform*, and *pisiform* bones. The lower, or *digital row*, consisting of *trapezium*, *trapezoides*, *magnum*, and *unciform* bones.

The os scaphoides is situated most externally of the cubital row, and immediately to its inner side is placed the lunar bone; both of them present superior rounded articular surfaces, to be connected with the radius, by which junction a very considerable portion of the wrist-joint is formed. The cuneiform bone is placed immediately on the inner side of the lunar, but does not extend so high as either of the last two bones. It is not in contact with either the radius or the ulna, being opposed to the under surface of the interarticular cartilage, which, together with this bone, completes the wrist-joint, and separates the ulna from that articulation. The cuneiform bone forms the inner or ulnad termination of the cubital row of the carpus; the fourth bone of this range, viz., the pisiform, being situated on its anterior surface, reaching into the palm of the hand.

Of the digital row, the os trapezium is the most external or radiad, and is situated between the os scaphoides and the first phalanx of the thumb: the trapezoid is placed on the inner side of the trapezium, between it and the os magnum, being connected, above, with the scaphoid, and below, with the metacarpal bone of the fore finger. Immediately on its inner side is found the os magnum, bounded, above, by the scaphoid and lunar bones; below, by the metacarpal bones of the middle, fore, and ring fingers; and lastly, to the inner or ulnad side of this row, is situated the unciform bone, having the cuneiform bone above, and the ring and little fingers below it.

The ossa scaphoides and trapezium on the outer side, and the pisiform and humillary process of the os unciforme on the inner side, present four prominences in the concave anterior surface of the carpus, which give attachment to the annular ligament, for the purpose of confining the tendons of the flexor muscles, and maintaining the lateral arch of the wrist.

The bones of the carpus present such peculiarities, as to render it necessary to give to each a separate description; and, according to the usual plan, I shall begin with the scaphoid bone, which is placed on the radial side of the cubital row of the carpus.

Cubital Row.

Os Scaphoides.

(ςκαφη a skiff, ειδος resemblance.)

The bone is so named from its resemblance to a boat, and is articulated, above, with the radius; below, with the magnum; on the outer side, with the trapezium and trapezoid; and on inner side, with the lunar bone. It therefore presents five *articulatory surfaces*. The upper surface is convex from within to without, and from before to behind, corresponding to the outer concave articular surface, on the inferior extremity of the radius.

The lower concave surface has its long axis from side to side, for the purpose of receiving a part of the rounded head of the os magnum, on the inner side of which is a crescentic, flattened, articular surface for the lunar bone.

The outer articular surface is placed obliquely, facing outwards and downwards; is divided by an indistinct ridge, to be connected with the trapezium and trapezoid bones.

The posterior, or dorsal surface of this bone, is marked by a deep groove, having a direction from within to without, which gives attachment to ligament.

The anterior or palmar surface, is also rough for the insertion of ligament; and being less expanded than the posterior, assists in forming the carpal arch.

Use.—This bone enters into the composition of the wrist-joint, above, and the articulation, between the two rows of the carpus, below.

The scaphoid bone does not give attachment to any muscle.

Os Lunare.

(Luna, the moon.)

The os lunare has received its name from its crescentic form, and presents, like the scaphoid bone, an upper rounded articular surface, to complete the articulation between the carpus and the radius. Below, this bone is concave from behind to before, to receive the inner surface of the head of the os magnum. The inner side presents a large flattened articular surface, for the cuneiform bone; and at the angle formed by these two last-named surfaces, is situated the apex of the unciform bone. The outer side is connected with the os scaphoides, by a flattened semilunar articulation. The dorsal and palmar surfaces of this bone are rough, for the attachment of ligament.

Use.—The os lunare assists in completing the wrist-joint, as well as the carpal articulations.

This bone does not give attachment to any muscles.

Os Cuneiforme.

(Cuneus, a wedge—forma, likeness.)

The cuneiform bone has derived its name from its wedge-like form, and is situated on the ulnar side of the cubital row of the carpus. It presents a superior flattened articular surface, to connect it with the lunar bone; an outer, somewhat concave surface, for its attachment to the unciform bone; a rounded surface anteriorly, for the pisiform bone; and a convex one, placed superiorly and internally, which corresponds to the under surface of the interarticular cartilage, separating the cuneiform bone from the ulna. This bone also presents an internal, a palmar, and a dorsal non-articular surface, all of which are rough for the attachment of ligaments.

Use.—The cuneiform bone, by its junction with the interarticular cartilage, completes the wrist-joint.

This bone does not give attachment to any muscles.

Os Pisiforme,

(Pisum, a pea.)

From its rounded figure, sometimes called the os orbiculare. It is placed in front of the cuneiform bone, with which it is connected by its only articular surface; this surface being flat and placed posteriorly. In front this bone is irregularly rounded and roughened, for the attachment of the lateral ligament.

Use.—From its position in front of the carpus, it completes the transverse carpal arch; and thus protects the vessels, nerves, and tendons, in their passage to the fingers.

Attachment of Muscles.—This bone receives the insertion of the flexor carpi ulnaris, and gives origin to the abductor minimi digiti. The ligamentum carpi ulnare is also attached to it.

The Digital Row.

The four bones of the digital row are placed in the following order, beginning from the radial side: the *trapezium*, *trapezoides*, *magnum*, and *unciform*.

Os Trapezium.

(τραπεζιον a four-sided figure.)

The os trapezium is irregular in its form, but somewhat resembles the mathematical figure from which it has derived its name: it presents *four articular*, and *two non-articular* surfaces.

The *superior* surface forms a slight concavity, to connect it with the scaphoid bone.

Its *inferior*, or *digital* surface, is sharp, and terminates rather to its inner side in a small articular face, which is lengthened from before to behind, and receives a part of the metacarpal bone of the fore finger.

Its *outer articular* surface, which is the largest, is concave from above to below, and convex from before to behind; and is articulated with the first phalanx of the thumb.

Internally, it is connected with the trapezoid bone, and presents, therefore, an articular surface for that purpose.

Its *anterior*, or *palmar non-articular* surface, is rough for the attachment of ligaments, and has a deep groove traversing it from without to within, and from above to below, for the passage of the m. flexor, carpi radialis.

Its *dorsal* surface is rough, slightly hollowed, and gives attachment to ligaments.

Use.—This bone differs from the rest of the digital row of the carpus, in forming part of a very moveable articulation, which allows the thumb to turn in every direction upon it, while the others admit of but little motion of their respective metacarpal bones.

Attachment of Muscles.—The flexor and extensor ossis metacarpi pollicis, flexor brevis pollicis, abductor pollicis, and abductor indicis, are connected with the trapezium.

Os Trapezoides.

This bone is somewhat of the same figure as that last described: it is situated immediately to the ulnar side of the os trapezium, and, like it, presents *four articular*, and *two non-articular* surfaces.

Its *superior articular* surface is somewhat concave, and is connected with the scaphoid bone.

Its *inferior* or *digital* surface, is divided into two articular faces, by a central ridge, which is received into the superior carpal extremity of the metacarpal bone of the fore finger.

The *internal*, or *ulnar* surface, presents a triangular articular face, which is in contact with the os magnum.

Its *external*, or *radial* surface, is connected with the trapezium, and is less than that by which this bone forms a junction with the os magnum. Of the two non-articular surfaces, the *dorsal* is the larger, and has its long axis placed obliquely from before to behind, and is rough for the attachment of the dorsal ligaments of the hand.

The *smaller palmar* surface, is also rough for the attachment of ligaments: it is so deeply seated in the palm of the hand, as to be concealed by the os trapezium.

Use.—This bone, besides assisting in the formation of the carpus, also supports the middle part of the metacarpal bone of the fore finger.

Attachment of Muscles.—The only muscle attached to the os trapezoides is part of the flexor brevis pollicis.

Os Magnum.

The os magnum is so named from its being the largest bone of the carpus, and is situated in the middle of the digital row.

Its *superior,* or *cubital* surface, forms a rounded articular apophysis, which is termed its *head,* and which is received into the articular cavity formed by the scaphoides, lunare, and unciform bones. The head is attached to the body of the bone, by a contracted portion which may be termed its *neck.*

Its *base,* or *inferior digital* surface, is somewhat triangular, and presents three articulatory divisions, the middle of which is much the largest, to receive the whole of the metacarpal bone of the middle finger; while the metacarpal bone of the fore and ring fingers rest on the lateral divisions.

Its *outer* surface presents two articulatory faces, the upper convex, for the scaphoid bone, and the inferior, of an irregular form, for the trapezoid bone.

Its *ulnar side,* is principally formed of a large flattened superior surface, which is connected with the os unciforme; and below this, the small portion of the articulatory surface, for the metacarpal bone of the ring finger, presents itself.

Two *non-articular* surfaces may also be described on this bone: the large posterior, or *dorsal* surface, rough for the attachment of the dorso-carpal ligaments; and its anterior, or *palmar* surface, narrowed to assist in forming the lateral arch of the carpus, for the passage of the flexor tendons of the wrist and fingers.

Use.—This bone enters principally into the formation of the carpal joint, and assists in supporting three of the metacarpal bones.

Attachment of Muscles.—The flexor brevis pollicis is the only muscle attached to the os magnum.

Os Unciforme.

(Uncus, a hook.)

This bone supports the metacarpal bones of the fourth and fifth fingers, and is situated between the magnum and cuneiform bones: it is somewhat of a triangular form, the *base* being placed below, and the *apex* above.

The *base*, or *digital* surface, is covered with cartilage, and divided into two nearly equal-sized articulatory portions by a ridge; these are slightly concave from before to behind, and receive the metacarpal bones of the fourth and fifth fingers.

The *apex*, *upper*, or *cubital* surface, forms an acute angle, which is covered with cartilage, to form an articulation with the os lunare; this junction being produced by the unciform bone wedging itself in between the magnum and cuneiform bones.

Its *radial*, or *outer* surface, is slightly convex; partly covered with cartilage, to connect it with the os magnum, and partly rough for the attachment of ligament.

Its *inner*, or *ulnar* surface, presents an articulatory face, which is concave from below upwards, for its junction with the cuneiform bone.

The *dorsal* surface of this bone, which is non-articular, is convex, and roughened for the attachment of ligaments.

The *palmar* surface is less than the dorsal, and is peculiar in having projecting forwards from it the *hook-like process*, from which the bone is named. This process is slightly curved, presenting a concavity towards the thumb, and a convexity inwards. It advances considerably into the palm of the hand, and gives a firm origin to the strong ligament which ties down the tendons of the wrist and fingers.

Attachment of Muscles.—Part of the flexor brevis pollicis, the flexor brevis, and abductor minimi digiti, arise from the unciform bone.

Practical Remarks.

Such is the description of the individual bones entering into the composition of the carpus: they are, however, so connected with each other, and with other bones, that they ought rather to be considered in the light of a compound whole, than as parts possessing individual uses; or, in other words, they present, when taken collectively an excellent illustration of that division of the osseous system, which we have already distinguished by the term short bones. With little or no motion between themselves, they form, by their union with each other, a strong bony arch, which, whilst it imparts great strength, affords protection to important structures, and moreover presents an extensive, though an irregular, articulatory surface, to admit of the varied movements of the hand upon the radius. In appreciating the use of the carpal bones, taken collectively, it may perhaps be objected that the os trapezium offers an exception, inasmuch as that bone forms a direct articulation with the thumb, and admits of extensive motion; this must, indeed, be admitted, but the exception is readily accounted for, the trapezium being the only carpal bone directly connected with a digital phalanx; for I am disposed to contend, with some French anatomists, that the formation, connexion, and functions of that joint, all tend to prove that what is commonly and erroneously called the metacarpal bone, ought more properly to be regarded as the first phalanx of the thumb.

The Metacarpal Bones.

(μετα after καρπος the wrist.)

These are usually described as consisting of five in number; but in consequence of the thumb being articulated with the carpus, in a manner quite peculiar to itself, we may with propriety consider the thumb as being formed of three phalanges, while the remaining fingers have intervening between them and the carpus, the four metacarpal bones. When entering into further detail of the functions of the hand, in my lecture on the skeleton, other reasons will be adduced for the propriety of this arrangement.

The four metacarpal bones form the second division of the bones of the hand, and are situated between the wrist and the fingers. They resemble each other in being cylindrical, consisting of a *body*, and *two extremities;* the *superior, upper*, or *carpal extremity*, being termed the *base*, is flattened and covered with cartilage, for their attachment to the carpus, and rough anteriorly and posteriorly, for the insertion of the carpo-metacarpal ligaments. The *inferior*, or *digital extremities,* are convex from before to behind, and flattened laterally, thus constituting the *head*, which is covered with cartilage: where the head of the bone is connected to the body, it is contracted, forming the *neck*, which is bounded in its circumference by small rough tubercles, for the attachment of the metacarpo-phalangeal ligaments: while the intervening portion of bone, termed the *body*, is broad on its dorsal surface, concave on its palmar aspect, and flattened laterally; but although they much resemble one another, each presents certain peculiarities requiring individual description.

Metacarpal Bone of the Fore Finger.

This is the longest of the metacarpal bones, and may be also known from the others by its *upper extremity*, or *base*, presenting a deep *sulcus*, by which it articulates with the trapezoid bone, separating an *outer articulatory* surface for the trapezium, from a *smaller one* on the inner side, for the magnum: the *ulnar side* of the base offers a flattened surface, which is in contact with the metacarpal bone of the middle finger. All these articulatory surfaces are covered by a continuous cartilage. Upon the *palmar surface* of the base, there is a roughness for the insertion of the m. flexor carpi radialis. The *dorsal* and outer surface of the base, is marked by the insertion of the m. extensor carpi radialis longior. On the ulnar surface of the head is a small *tubercle*, for the attachment of the metacarpal ligament, connecting it with the metacarpal bone of the middle finger. The *body* of this bone is triangular, concave on its ulnar side only, for the lodgement of the prior indicis muscle.

Metacarpal Bone of the Middle Finger.

The *base* is situated obliquely, and forms one *articular* surface only, to be connected to the magnum. On either side the base of the bone is covered with cartilage, where it is in contact with the metacarpal bones of the index and ring fingers. The *dorsal* surface is broad and rough for the attachment of ligaments, and furnished with a tubercle for the insertion of the m. extensor carpi radialis brevior. Its *palmar* surface is very contracted, thus tending to produce the transverse arch of the hand. The *head* and *body* of this bone do not require any further description. The adductor pollicis muscle arises from this bone.

Metacarpal Bone of the Ring Finger.

The *base* of this bone is small, but presents four articulatory surfaces: two above, a large *inner* one to be connected to the unciform, and a small *ridge* to join it with the magnum. It is connected with the middle finger on its outer, and with the little finger on its inner side. The *body* of this bone is narrower than any of the other metacarpal bones.

Metacarpal Bone of the Little Finger.

Its *carpal* articulatory surface, for its attachment to the unciform bone, is convex from before to behind, and concave from side to side: the *radial aspect* has an articulatory surface for the metacarpal bone of the ring finger, while its *ulnar* surface projects a little beyond the unciform bone, and is roughened for the insertion of the extensor carpi ulnaris, and origin of the abductor minimi digiti muscle. The *radial* side of the head of this bone only presents a tubercle, for the attachment of the inter-metacarpal ligament.

The Fingers.

(Phalanges digitorum. φαλανξ a regiment.)

The fingers, which are composed of fifteen small bones, termed the phalanges, comprehend the third division of the bones of the hand.

Each finger is furnished with three of these bones, and in all, that phalanx, nearest to the metacarpal bone is the largest, the inferior the smallest, while the middle are intermediate in size. All the phalanges have their superior or metacarpal extremity larger than the inferior, excepting in the first phalanx of the thumb, in which the inferior offers greater dimensions than its superior extremity. Their dorsal surfaces are convex, and their palmar concave.

The Superior, or Metacarpal Phalanges.

These five bones differ but little from each other, excepting in size and length. Their *superior extremity*, which is the largest, presents an *oval* articular surface, having its long axis from side to side, and being concave from behind to before, to be articulated with the rounded extremity of the metacarpal bones. On each side of this articular surface, is situated a small *tubercle* for the attachment of the lateral ligaments. Their *inferior extremity* is terminated by two small condyles, separated from each other by a shallow groove: these condyles present a larger anterior than posterior articular surface, and are connected with their corresponding middle phalanges. The *bodies*, or middle parts of these bones, are concave on their palmar surface, and lodge the tendons of the flexor muscles of the fingers. Their *dorsal* surface is convex, and is covered by the extensor tendons: on each side are placed the digital arteries and nerves, and fibrous sheaths, which are attached to the tendons of the flexor and extensor muscles. The upper phalanx of the thumb differs, however, somewhat from this description, in having its superior extremity less than any of the other corresponding bones, and being, indeed, smaller than at its inferior end; its superior articular surface also differs in being concave from before to behind, and convex from side to side, for its articulation with the os trapezium. Indeed, this bone is described by most anatomists as the metacarpal bone of the thumb, and that the thumb has only two phalanges; but the motion which this bone enjoys, when contrasted with the fixed position of the metacarpal bones, the consideration of its ligaments, and the insertion of the muscles into it, which are destined to move the thumb, are circumstances which sufficiently shew the propriety of classing it amongst the phalanges, rather than the metacarpal bones.

The Middle Phalanges

Differ but little from each other, excepting in length; that of the middle finger being the longest, and of the little finger, the shortest and thinnest. Their *superior* extremity presents two small concave articular surfaces, separated from each other by a slight ridge, which prolongs itself into a process upon the dorsal surface, and overlaps their articulation with the first phalanx. This extremity is rough on each side for the attachment of lateral ligaments, to strengthen their junction.

Their *inferior* extremity is precisely similar to those of the first phalanges: these phalanges have inserted into them the m. flexor sublimis.

The Inferior Phalanges

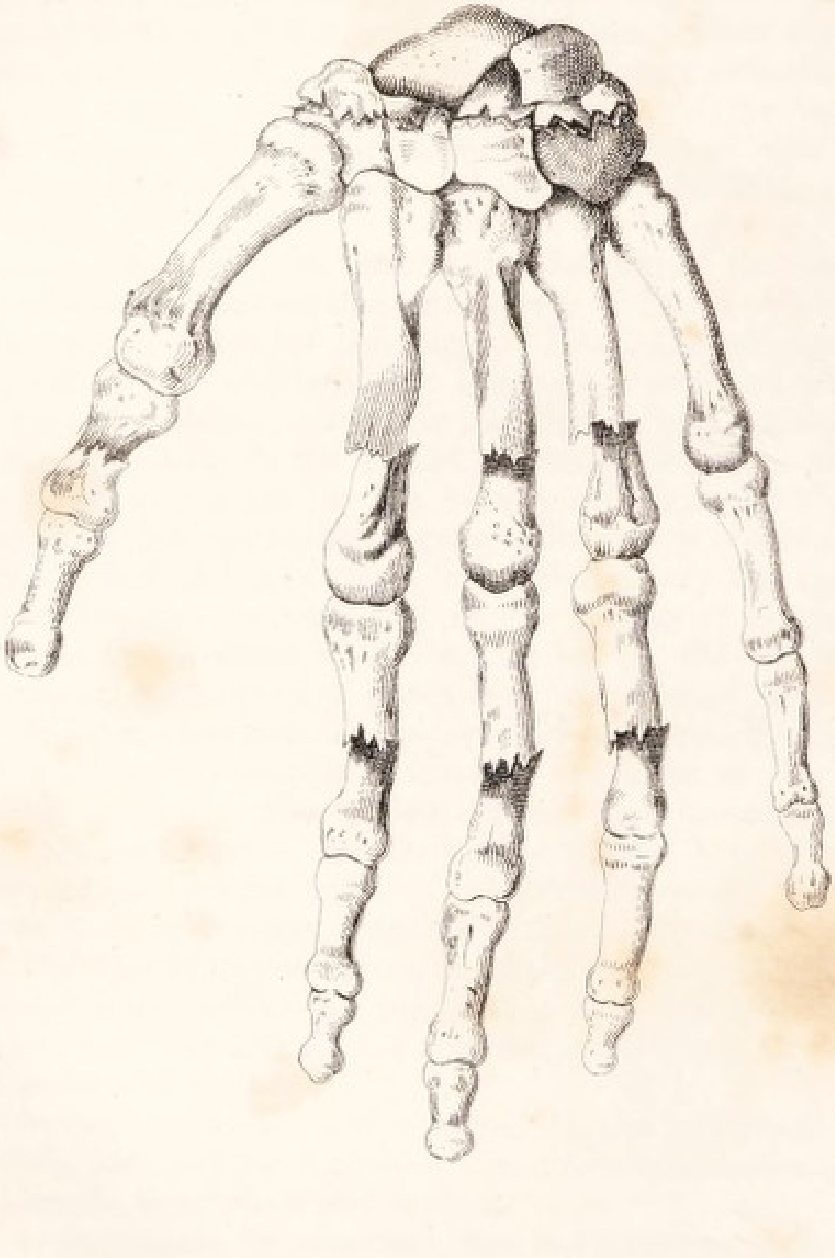
Only differ in size, that of the thumb being the largest, and of the little finger the smallest; their *superior* extremity is similar to those of the second phalanges. Their *inferior* extremity is rounded, is not furnished with any articular surface, is very rough, and larger than the *body* of the bone; it is convex upon its posterior surface, and covered with the nail; concave anteriorly, and gives attachment to the flexor profundus muscle.

It is impossible, on viewing the skeleton of the hand, not to be struck with the number and variety of bones which compose the osseous system of this organ. From this arrangement, we should at once conclude that this part is endowed with a high degree of mobility, admirably adapting it to the complexity of action requisite to the almost innumerable offices which it is destined to execute in the human subject. In the various orders of the mammalia, a great difference is observable in the construction and uses of the fore extremities; the approach to perfection may be estimated by the number of bones, and the consequent diversity of action; whilst, on the contrary, diminution of the number of bones, and limitation of motion, reduce them to mere organs of support and progression. This scale of organization may be traced in the tribe of the simiæ, as being nearest to the human subject, and in which the hand is furnished with a thumb, thereby fitting it to a number of purposes, which the habits of the animal require.

In the quadrumina, where the thumb is wanting, the action of the fore extremity is more circumscribed, and further removed from perfection; but still performing the complicated function of locomotion, and climbing, as well as a limited degree of prehensile power.

In the ruminantia and solidungula, the prehensile power is totally lost, and the function of their fore extremities is confined to simple locomotion and support.

It may again be observed, that the presence and perfection of the clavicle bears a strict proportion to the development of the hand.



Attachment of Muscles to the Metacarpus.—These muscles may be classed into those, which are common to all, and those, which are proper to individual bones of the metacarpus. The first class comprises the seven m. interossei. Of the second class, to the metacarpal bone of the fore finger; anteriorly, the m. flexor carpi radialis, posteriorly, the m. extensor carpi radialis longior are attached; to that of the middle finger, the m. extensor carpi radialis brevior, and the m. adductor pollicis; and to that of the little finger, the m. extensor carpi ulnaris, and the adductor minimi digiti.

Attachment of Muscles to the Phalanges.—These muscles may also be divided into those, which are common, and those, which are proper to some of the fingers.

Those which are common, and which are inserted into all the fingers, excepting the thumb, are the m. lumbricales into the upper or first phalanges; the m. flexor sublimis perforatus into the second phalanges; and the m. profundus perforans into the third phalanges; while the extensor digitorum communis is inserted into the dorsal surface of them all by a tendinous expansion, which receives also the attachment of the interossei.

The Muscles proper to the Thumb—are eight, viz., three flexors, flexor ossis metacarpi (which would be better named the flexor primi internodii), into the first phalanx; the flexor brevis pollicis, or secundi internodii, into the second phalanx; and the flexor longus pollicis, or tertii internodii, into the third phalanx:—these are inserted into their palmar surface. Into their dorsal surface, is inserted the extensor ossis metacarpi, or primi internodii, into the first; the extensor secundi internodii into the second; and the extensor tertii internodii into the third phalanx.

The abductor and adductor muscles proper to the thumb are inserted, through the medium of the ossa sesamoidea, into the joint between the first and second phalanges.

The Muscles proper to the Fore Finger—are two, the m. extensor indicis, into the dorsal surface of the two last phalanges; and the abductor indicis, into the outer and back part of the first bone of the fore-finger.

The Muscles proper to the Little Finger—are three, the m. flexor brevis minimi digiti, and abductor minimi digiti, into the root of the first phalanx; and the adductor minimi digiti, into the metacarpal bone supporting this finger.

Practical Remarks.

The fractures to which the bones of the hand are liable, may be considered as they may occur either to the carpus, metacarpus, or phalanges.

Fractures of the Bones of the Carpus.—This division of the hand is composed, as has already been described, of eight small bones, which are so closely articulated with one another, each presenting so small a surface and so spongy a texture, as rarely to admit of fracture, unless indeed it be occasioned by the application of some very heavy weight, when comminuted fracture of several of the bones may take place, attended consequently with considerable injury to the soft parts, so as frequently to render amputation necessary. A gun-shot wound, or the application of any concentrated force upon one of the bones of the carpus only, might produce solution of its continuity; in which case the treatment would consist of removing the comminuted pieces of bone, and poulticing as in common cases of gun-shot wound.

Fractures of the Bones of the Metacarpus.—These bones are more liable to fracture than those of the carpus, in consequence of their greater comparative length, as well as of their more compact structure. It is an accident which does not unfrequently occur to pugilists. When a metacarpal bone is fractured, the broken extremities of the bone are drawn slightly forwards into the palm of the hand, by the interossei muscles. The treatment consists in placing a ball in the injured hand, and drawing the fingers tightly over its surface, and retaining them in that position by bandages; the hand at the same time, being kept at rest in a sling.

Fractures of the Phalanges.—From the manner in which these bones are articulated at the extremity of the hand, they are liable to fracture only from the immediate application of any force upon them; and therefore considerable contusion of the soft parts is a necessary concomitant. The fractured extremities of the bones are drawn forwards and slightly outwards, by the action of the flexor muscles; the deformity of the finger, the unnatural mobility of the bone, and crepitation, render the nature of the accident obvious. The treatment consists in extending the finger, in the application of paste-board splints and roller, and the hand being confined in a sling. It may further be observed, however, that when the extreme phalanx is broken, from the small size of that bone, as well as from its having the nail and its ungual gland connected with it, it is better at once to amputate than attempt to save it, as the process of reparation in this accident is always tedious and uncertain.

The Lower Extremities.

The bones of the lower extremities are connected with the inferior part of the trunk, and are divided into the *thigh*, *leg*, and *foot*.

The Os Femoris.

(Fero, to bear.)

This bone alone forms the thigh; is the longest and heaviest bone in the body, and is situated between the bones of the pelvis and the tibia. It is divided into *head*, *neck*, *body*, and *condyles*. The *head*, which forms its articulatory surface for its attachment to the bones of the pelvis, is of a rounded form, and directed upwards, inwards, and slightly forwards, forming about three-fourths of the segment of a circle. It is every where covered with cartilage, excepting a small fossa placed upon its inner and under part, to which the ligamentum teres is connected to the bone itself. The outer circumference of the head is encircled by a rough line, marking the precise point of demarkation between the head and neck; this edge giving the inner attachment to the capsular ligament. From this point the *neck* proceeds downwards and outwards to the body of the bone, at an angle varying with the age of the individual, and at the adult period of life is about 45°. It is more slender where attached to the head of the bone: it is somewhat triangular in its form, presents a plane surface anteriorly, and is concave on its outer aspects. It is roughened, for the firmer attachment of the capsular ligament; and penetrated with foramina, for the transmission of vessels into the cancellated structure. The neck of the bone, where attached to the shaft, expands itself so as to produce two *processes:* the upper and outer one, termed the *trochanter major,* projects upwards, so as, in some measure, to rise above the neck, and is directed slightly backwards. It presents a convex external surface, divided into a smooth upper and a rough lower half; the upper smooth surface marking the situation of a bursa for the insertion of the m. gluteus medius et minimus. Internally the trochanter major is hollowed by a deep fossa, for the attachment of the rotator muscles of the thigh outwards. Posteriorly the trochanter major terminates by a rough line, which is directed downwards, backwards and inwards, and extends to a rounded tubercle denominated the *trochanter minor.* This line receives the insertion of the m. quadratus femoris, and gives attachment to the capsular ligament, it is called the *linea quadrata.* The trochanter minor is rounded, faces inwards and downwards, and appears equally to terminate the inferior line of the neck of the bone as it does the linea quadrata. It is hollowed anteriorly, for the insertion of the m. psoas magnus and iliacus internus; while it is roughened posteriorly, forming a part of the *linea aspera.*

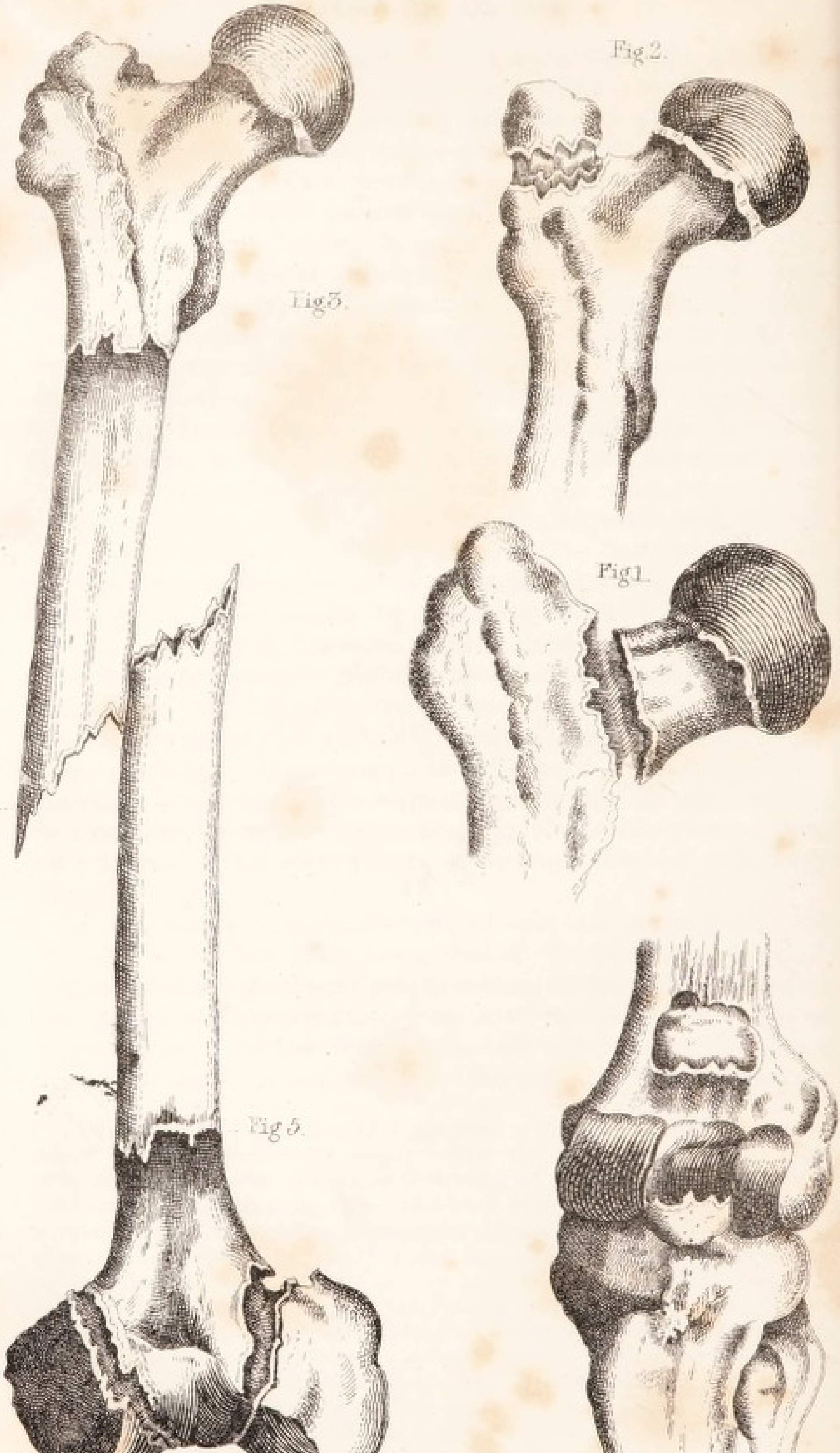
The *body* or *shaft* forms the longest portion of the bone, and is situated between the trochanters and condyles: it diminishes in size towards its centre, and presents an anterior smooth convex surface, over which passes the extensor muscles of the knee-joint. The sides of the shaft of the bone are flattened for the attachment of the vasti muscles, and are bounded by an acute edge on the inner, and an obtuse edge on the outer side, which pass backwards to meet in a single line to form a part of the linea aspera, which is situated on the posterior part of the bone. The posterior surface is concave from above to below, for the lodgment of the flexor muscles of the knee-joint, and is distinctly divided into a superior, middle, and inferior third. The superior third is somewhat flattened, and presents two lines proceeding from the trochanters: these lines meet in the middle third, and form, with the angles of the sides of the bone, the *linea aspera.* When in the lower third they again separate, to terminate in the two condyles. At the junction of the upper with the middle third, on this surface of the bone, a *foramen* is seen for the transmission of the nutritious artery, the direction of which is from below upwards: and at the junction of the middle with the lower third, the inner crus of the linea aspera presents a *groove,* marking the situation where the femoral, becomes popliteal artery.

The inferior extremity of the bone is expanded, forming two large articulatory surfaces, which are termed the *external* and *internal condyles.* These articulatory surfaces meet anteriorly, to form a pulley-like *articulatory depression* for the patella; this surface being covered with cartilage continuous with the two condyles. Inferiorly the condyles diverge; the external presenting a rounded articulatory surface, convex from behind to before, and slightly from side to side, with its outer more prominent than its inner edge. The internal condyle is necessarily longer than the external, from the obliquity with which the bone descends to come in contact with the tibia: it is more contracted and convex from side to side than the outer condyle, and has a longer axis from before to behind. The articular cartilage, which covers the condyles, projects further posteriorly than anteriorly. A deep cleft separates the two condyles from each other posteriorly, to lodge and protect the popliteal vessels and nerves. The *non-articular* or *lateral surfaces* on the two condyles are flattened and rough for the attachment of ligaments, also allowing the vasti muscles to pass over them, to be inserted into the patella. A *tubercle* is seen posterior to the central axis of the condyles, for the attachment of the lateral ligaments; and behind the tubercle, upon the inner condyle, is a pit, for the tendon of the adductor magnus muscles; and on the outer condyle, a fossa which lodges the m. popliteus, when the knee is flexed. The *inferior extremity* of the body of the bone is perforated by a number of vessels passing into the interior. This bone assists in forming the hip and knee-joints.

In all classes of mammalia the femur is a single bone, and its form varies but little from that of the human subject; its length, however, is always proportionate to that of the metatarsus, being short in such animals as possess a long metatarsal or cannon bone. In the ruminantia and solidungula the femur is so short as to be concealed by the muscles of the abdomen.

Attachment of Muscles.—The gluteus, medius et minimus are inserted into the trochanter major: from the posterior part of which process a rough line marks the insertion of the m. gluteus maximus. Into the deep pit upon the inner and back part of the trochanter major is inserted the m. pyriformis, geminus superior and inferior, obturator externus and internus: and into the line between the trochanters, the m. quadratus femoris. Into the fore part of the trochanter minor are inserted the m. psoas magnus and iliacus internus: into a rough line, passing from the trochanter minor, is inserted the pectinæus: these three last muscles being flexors of the hip-joint. Into the whole length of the inner edge of the linea aspera, the three heads of the m. triceps adductor femoris are inserted. The upper and fore part of the shaft of the bone gives origin to the m. cruræus, while the m. vasti arise on either side, from the linea aspera: this line also posteriorly, in its lower third, gives origin to the short head of the m. biceps flexor cruris.

Plate 8.



Warr lith.

From both condyles the m. gastrocnemius externus arises: and from the external condyle also the m. popliteus and plantaris. Thus it may be observed, that the thigh-bone receives the insertion of all the muscles of the hip-joint, and gives origin to some of those of the knee and ancle.

Practical Remarks.

Notwithstanding the great strength of this bone, still, as may be said of every cylindrical bone, it is liable to fracture in any part of its extent, either at the point of immediate application of a force, or it may give way in its centre, from a fall on the condyles; in which case the upper part of the bone forms the point d'appui, and the natural curvature of the bone has a tendency to be increased beyond its power of extension, and it necessarily yields. In consequence of the numerous muscles which are attached to this bone, it is obvious that the fractured extremities may vary in their direction, depending upon the influence of muscular power, and the precise point at which the femur is fractured; therefore we will consider individually those particular parts of the bone, which, when fractured, invariably take a certain direction.

Fracture of the Neck.—(Vide Fig. 1., *Plate IX.)*—It is unnecessary for me to offer any remarks upon the different opinions which surgical writers have entertained, concerning the union or non-union of this fracture. The diagnosis is always sufficiently distinct to point out the nature of the injury: first, this accident only occurs at an advanced period of life; the limb is shortened and everted; slight extension brings it to its natural length; and rotatory motion during extension produces crepitation. The only accident for which this can be mistaken, is dislocation upon the pubes; but the circumstance of the one being unnaturally fixed, while the other is capable of inordinate motion, will lead to a just knowledge of the injury. From the experience I have had upon this subject, I feel I cannot do better than recommend the practice adopted by Sir Astley Cooper, as laid down in his work on Fractures and Dislocations.

The Trochanter Major (Vide Fig. 2., *Plate IX.)* is sometimes detached from the shaft of the bone;—an accident which it is difficult to detect, in consequence of the small size of the separated portion, and from its not producing any alteration in the direction or length of the limb; the fractured portion of bone being drawn up by the action of the m. gluteus medius and minimus, a considerable separation frequently occurs. In consequence of these two muscles being wholly inserted into the trochanter major, the adaptation of the fractured extremity is difficult both to produce and to maintain; and can only be accomplished by the abduction of the injured limb, in addition to the other ordinary means. I have had an opportunity of witnessing this accident, and experienced all the difficulties I have described.

Fractures immediately below the Trochanter Minor.—(Vide Fig. 3., *Plate IX.)*—This accident differs from all other fractures of the thigh, excepting that last described, from the greater displacement occurring in the upper than the lower portion of the bone, in consequence of the insertion of the psoas magnus and iliacus internus muscles; the upper fractured extremity is drawn forwards, so as to form a tumour in the groin, which deformity can only be obviated by bending the pelvis upon the thigh, so that the patient must be placed in bed, nearly in a sitting posture, during the progress of reparation.

Fracture in the middle of the Shaft.—(*Vide Fig.* 4., *Plate IX.*)—When this portion of the bone is fractured, a shortening of the limb invariably takes place, which is produced by the action of those muscles which are attached to the whole length of the thigh bone. The most usual position of the fractured extremities is, for the lower portion to be drawn upwards and inwards by the adductor muscles, while the upper is thrown outwards by the action of the m. gluteus maximus, forming in this situation a perceptible protuberance. This is not, however, the invariable direction; for if the fracture occurs midway between the insertion of the m. gluteus maximus and the external condyle, the m. vastus externus will draw both portions in such a direction as to form a salient angle outwards, in which case very little shortening occurs.

Transverse Fracture immediately above the Condyles.—(*Vide Fig.* 5., *Plate IX.*)—In this case, the m. gastrocnemius externus, plantaris, and popliteus, draw downwards and backwards the inferior portion of the bone, so that the inferior extremity of the upper part, appears to be the one displaced.

In Fractures of the Condyles, the vasti muscles passing around them to be inserted into the patella, admit of but little displacement. They have a slight tendency to be drawn backwards by the m. gastrocnemius externus, and the inner one upwards by the tendon of the m. adductor magnus.

Fractures of the Thigh may be considered more difficult to manage than fracture of any other bone; and principally in consequence of the concomitant injury to the soft parts, inseparable from the degree of violence necessary to produce its solution of continuity, and the great power of the muscles rendering it difficult to maintain the coaptation of the fractured extremities.

In all fractures, the causes of the displacement of the fractured portions of bone, is muscle; and as coaptation is necessary for the cure, it becomes the object of the surgeon to place the limb in that situation best adapted mechanically to prevent the influence of muscles, as well as to subdue their irritability by constitutional means. For the first indication, various apparatus have been invented, and numerous positions of the fractured limb recommended. It occurs to me, however, that no general practice, no constant rule, can be laid down as the best. The surgeon's mind, in every case, can alone form the means to be adopted, as applicable to the individual instance; bearing in mind, that coaptation must not only be produced, but preserved for a longer or shorter period. From the size of the femur, its reparation is not completed, under ordinary circumstances, in less than fifty days.

The second division of the bones of the lower extremity, or leg, is composed of the *tibia*, *patella*, and *fibula*.

The Tibia

(Tuba, a pipe or flute.)

Is the largest bone of the leg, is placed on the inner side, and enters into the composition of the knee and ancle-joints; it is situated between the femur and tarsus, and is divided into a *body*, and *two extremities.*

The *superior extremity*, or *head*, is of an irregular oval form, having its long axis from side to side, with a convex anterior, and a concave posterior edge, or circumference. Its upper surface presents two *articulatory faces,* an external and an internal one, to receive the corresponding condyles of the femur, which they resemble somewhat in form, the *internal* one being oval from behind to before, and deeper than the *external* one, which is nearly circular. These two articulatory cavities are separated from each other by a *spine* in the centre, and by a roughened *cavity* behind and before. The spine is bifid, and has a pit placed between its projecting points; their summits are covered with the cartilage of the articular cavities of the tibia. The roughened *cavities*, anterior and posterior to the spine, give attachment to the ligaments of the semilunar cartilages, and to the crucial ligaments.

The *circumference* of the head of the tibia, below the articulatory surfaces, is rough for the attachment of the ligaments of the knee-joint, and presents an *anterior*, a *posterior*, and *two lateral regions.* The *anterior region* is flattened and triangular, having a smooth surface for the ligament of the patella to play over it. The *posterior region* is slightly hollowed, forming a part of the popliteal fossa. The two lateral boundaries of the head form what are termed the *tuberosities* of the tibia: the *internal* one is larger than the external, and upon it may be observed, at the posterior part, an impression to receive the insertion of the m. semi-membranosus. The *external* tuberosity forms the greater part of a sphere than the internal one, although of a smaller circle; and upon its posterior part is situated a small, convex, rounded, *articular surface,* facing downwards, backwards, and slightly outwards, for the attachment of the fibula. The tuberosities on either side, just posterior to the long axis of the head of the tibia, are marked for the attachment of the lateral ligaments of the knee-joint. The *body* of the tibia begins immediately below the head of the bone: it diminishes in size as it passes downwards, as far as the junction of the middle with its lower third; and at that point it increases again in size, to enlarge itself into its lower extremity. The body is of a triangular form, and presents an *internal*, an *external,* and a *posterior face;* an *anterior*, an *internal*, and an *external angle.*

The *internal face* is smooth and convex in all its length, excepting just at its upper part, where it is broadest; and there it is somewhat roughened, concave, and is covered by the tendons of the m. sartorius, gracilis, and semi-tendinosus muscles. The rest of the internal surface is only covered by skin and fascia, and terminates below in forming the inner projecting portion of the inferior extremity.

The *outer face* presents less surface than the internal; is concave on its upper half, and convex below, where it becomes directed more forwards than outwards. The upper broader concave part gives origin to the m. tibialis anticus, and extensor longus digitorum; the lower third is covered by the tendons of those muscles, as well as of the extensor proprius pollicis, and peroneus tertius.

Its *posterior surface* may be considered as the largest of the three, and is marked above by an oblique line, the *linea poplitea*, which begins immediately below the articular face on the outer tuberosity for the fibula, and proceeds downwards and inwards, to terminate at the inner angle of the bone, leaving a triangular space above it, for the attachment of the popliteus muscle; whilst the line itself gives attachment also to the soleus, tibialis posticus, and flexor longus digitorum muscles, which cover the posterior surface of the tibia. Just beneath the linea poplitea is found the *foramen*, for the nutritious artery of the bone, which takes its direction from above to below.

The *three angles* of the tibia separate these surfaces from each other.

The *anterior angle* is also called the spine of the tibia: it begins above from the *anterior tuberosity* of the tibia, and proceeds downwards to the inferior extremity of the bone,—not, however, in a straight course, but so as to produce a sigmoid line, presenting a concavity outwards for its upper, and inwards, for its lower half. The *anterior tuberosity*, from whence this line begins, gives attachment to the ligamentum patellæ, while the line itself has attached to it the fascia of the leg.

The *internal angle* begins from the roughness on the inner tuberosity of the tibia, for the insertion of the internal lateral ligament, and proceeds downwards the whole length of the bone to the inferior extremity: above, it is obtuse and rounded; below, it becomes more acute. The superior third gives attachment in part to the popliteus muscle, and internal lateral ligament of the knee-joint; to the rest of its extent, the common flexor of the toes is attached.

The *external angle* is the sharpest of the three, and gives attachment to the interosseous ligament.

The *inferior* or *tarsal extremity*, is smaller than the superior; but, like it, is furnished with an articular surface. This portion of the bone is somewhat quadrilateral, and has distinguished upon it, therefore, an *anterior*, a *posterior*, an *external*, and an *internal aspect*. *Anteriorly*, it presents a roughened transverse line, to which is attached ligamentous fibres to strengthen the ancle-joint. *Posteriorly*, it is very similar in form, and in the same manner roughened: it is furnished with a groove, which is directed from above to below, for the passage of the tendon of the flexor proprius pollicis muscle.

Internally, the inferior extremity projects downwards, beyond the rest of the base, and forms a large protuberance, which is termed the *malleolus internus.* This process is convex and scabrous on its inner surface, to give attachment to ligament: on its outer, or fibular surface, it is concave from before to behind, and covered with *cartilage* to be connected with the astragalus. *Anteriorly*, it is sharp and rough, for the connexion of ligament. *Posteriorly*, it is grooved, for the passage of the tendon of the tibialis posticus muscle.

The *outer*, or *fibular aspect* of the tarsal extremity of the tibia, presents a triangular articular surface, which is concave from before to behind, and forms, by its junction with the fibula, the inferior tibio-fibular articulation. This surface is placed in a line posterior to the articular surface, for the superior articulation of the fibula.

The *articular surface* for the astragalus, which forms the inferior extremity of the tibia, is of a square form, concave from behind to before, and deeper on its inner than its outer side: it is covered with cartilage continuous with that which lines the fibular aspect of the malleolus internus.

Use.—The tibia assists in forming four articulations, viz.:—the knee, the ancle, and the superior and inferior tibio-fibular articulations; besides giving attachment to numerous muscles

Attachment of Muscles.—Through the medium of the ligamentum patellæ, the rectus, cruralis, and two vasti muscles are inserted into the anterior tuberosity; into the posterior part of the internal tuberosity, the m. semimembranosus; into the upper part of the inner face of the body, the m. sartorius, gracilis, and semitendinosus, are inserted. From the outer face arise the m. tibialis anticus, and extensor longus digitorum; and the popliteus, soleus, tibialis posticus, and flexor longus digitorum, have origin from the posterior face of the tibia.

The Patella.

(Patina, a dish.)

This bone may be considered as the largest sesamoid bone in the body, being suspended between the tendon of the extensor triceps cruris and the ligamentum patellæ. It bears also considerable analogy to the olecranon; the only difference being that the olecranon is attached by bone to the ulna, while the patella is fixed to the tibia by tendon only.

The patella is irregularly triangular, and is so situated at the anterior part of the knee-joint, as to have its *base* above, and its *apex* below. It also presents an *anterior* and *posterior surface.*

Its *anterior surface* is convex, rough and striated, as if marked by the fibres of the tendon of the extensor muscles. It is also perforated with foramina for the passage of blood-vessels.

Its *posterior surface* is smooth and covered with cartilage, but is divided into two distinct articulatory surfaces by a middle convex ridge; these surfaces corresponding to the condyles of the femur, the external one being larger and rounded, by which the right patella may be known from the left. The circumference of the patella is rough, for the attachment of the synovial membrane of the knee-joint.

The *base*, or superior edge, is flattened, and has attached to it the extensor tendon.

The *apex* is pointed, and gives attachment to the ligamentum patellæ.

Use.—The patella serves to protect the knee from injury, and also gives attachment to the extensor muscles of the leg.

This bone forms the stifle of the horse.

The Fibula,

(Fibulo, to clasp or fasten.)

Is situated on the outer side of the leg, is of the same length as the tibia, but is much more slender; it is so situated, with respect to the tibia, as to be placed behind its level.

This bone is divided into its *body* and two *extremities.*

Its *upper extremity*, or *head*, is of an irregular form, but somewhat rounded, and presents an articular surface, which is concave from behind to before, faces upwards, inwards, and forwards, to be articulated with the external tuberosity of the tibia. Immediately posterior to this surface, a *process* of bone rises up of a pyramidal form, which serves to strengthen and protect the superior tibio-fibular articulation. The circumference of the head of the fibula is rough, for the attachment of ligaments, and also for the tendon of the biceps flexor cruris muscle.

The *body* is twisted and irregular in form, but is somewhat triangular; and is bent with a slight curve outwards. Like the tibia, the body of this bone may be described as possessing three *faces* and three *angles:* the faces distinguished as an *external*, an *internal*, and a *posterior;* and into an *external*, *internal*, and *anterior* angle.

The *external face* is twisted, so as above, to be directed forwards, and below backwards: it is somewhat hollowed in its upper third, where it gives attachment to the two peronei muscles.

The *internal face* is also twisted, but in a contrary direction to the last; so that above it is directed backwards, and below forwards: the centre of this face is hollowed out, to lodge the muscles situated between the tibia and fibula in front. It also gives attachment to the extensor longus digitorum, and the extensor proprius pollicis muscles.

The *posterior face* is less twisted than the other two, and is more convex. It is roughened above for the origin of the soleus muscle, and below it gives attachment to the flexor longus pollicis. About the middle of the bone on this aspect the *foramen* is seen for the nutritious artery, which is directed from above to below.

The *external angle* proceeds from the outer side of the head of the fibula, downwards and backwards in a twisted direction, so as to separate the external from the posterior face of the bone, and assist in giving attachment to the muscles on each aspect, viz.—behind, to the soleus and flexor proprius pollicis; and externally, to the peronei muscles.

The *internal angle,* which is most acute in its centre, forms the point of junction between the internal and posterior faces of the bone, and assists in giving attachment to the muscles of each region, and also to the interosseous ligament.

The *anterior angle*, which proceeds downwards from the fore part of the head of the fibula, between the external and internal faces, forms the acutest angle of the three: the outer edge of this angle has the peronei muscles attached to it, and its inner edge the extensor communis digitorum and peroneus tertius. It should, moreover, be observed, that the body of the fibula sometimes presents more angles than have here been described; but they will be found only as irregularities upon the faces of the bone, depending on the size and strength of the muscles attached to it.

The *inferior extremity*, or *malleolus externus* of the fibula, is the largest part of the bone, and descends below the internal malleolus of the tibia. It is of an oblong form, flattened, and terminates by a projecting point. Its *external surface* is convex and rough, lying immediately underneath the skin, forming what is termed the outer ancle: the *inner* or tibio-tarsal surface presents an *articular face*, concave from behind forwards, which connects it with the astragalus; and immediately above this, is seen a *rough depression*, which attaches this bone to the tibia; the anterior edge of the malleolus externus is thin and rough, while the posterior forms an obtuse edge, but equally roughened for the attachment of the ligaments which serve to strengthen the ancle and inferior tibio-fibular articulations. The projecting *apex* of the inferior extremity of the fibula, has connected with it the external lateral ligament of the ancle-joint, and is furnished with a *groove* at its posterior part, in which the tendons of the peronei muscles pass.

There is considerable variety in the form and attachment of the bones of the leg in different mammalia. In the simiæ, however, they much resemble those of the human subject: the spine of the tibia only being much less prominent. In the ruminantia the fibula does not exist, so that the malleolus externus may be considered as an additional tarsal bone. In the horse the fibula is a rudiment, only being articulated by ligament to the upper part of the tibia, and is the seat of the disease called spavin. In the bat the fibulæ are very long, slender, and twisted, so that they face inwards towards each other. In the human subject the tibio-fibular articulations are very rarely anchylosed.

Use.—The fibula assists in the formation of the ancle, and of the superior and inferior tibio-fibular articulations. It also gives insertion to one of the muscles of the knee-joint, and origin to some of the muscles of the foot and toes.

Attachment of Muscles.—To the external face, the m. peroneus longus and brevis, and the m. biceps flexor crusis ; to the inner face, the extensor longus digitorum, and extensor proprius pollicis; and on the posterior face, the m. soleus, tibialis posticus, and flexor longus pollicis pedis, are attached.

Practical Remarks.

The *patella* may be fractured transversely, or with different degrees of obliquity, but the longitudinal fracture rarely happens; for as the solution of continuity in this bone most frequently occurs by violent action of the extensor muscles, the transverse fracture is thus produced.

A fracture in this bone in a longitudinal direction is usually caused by a fall upon the bone itself, at a time when the knee being bent, the patella at its extremities is resting upon the femur and the tibia, whilst its middle part is without support, and consequently most liable to yield. Under these circumstances, the bone is sometimes comminuted. The injury may be discovered by examining the bone, when a fissure may generally be felt; displacement does not occur as when the fracture is transverse. The treatment consists in extending the leg, and placing a circular bandage around the knee,—at the same time enjoining rest, and using every precaution to guard against inflammation.

When a *transverse fracture* is produced, and which most frequently happens from the inordinate contraction of the extensor muscles in the act of saving oneself from falling backwards, the superior portion of the bone is drawn upwards by the muscles for an inch from the lower, (*Vide Fig.* 6., *Plate IX.*) and a considerable hollow may be felt between the two. The patient loses the power of raising the foot from the ground, and consequently of progressive motion, excepting in a retrograde direction, by which act the foot can be drawn along the surface of the ground, the knee being kept extended.

Treatment.—The limb should be extended to the utmost, bending the thigh upwards upon the pelvis, so that the limb is placed at an angle of 30° from the horizontal line to the trunk. By this position, the ligamentum patellæ, as well as the extensor muscles, are relaxed, and the upper portion of the fractured patella may readily be drawn down to the lower, which is connected with the tibia. A bandage should then be rolled on the thigh, so as to support, and at the same time diminish the irritability of the muscles; and this bandage should be passed from the thigh to the leg in the form of the figure of 8, behind the knee-joint, so as to cross one another in the ham for several turns, and thus embrace the sides of the patella; it may then be continued to the foot as a

Plate II

Fig. 1.

Fig. 2.

Warr lith.

common roller, thus preventing partial compression. A circular strap should then be buckled on above, and another below the fractured patella, and these made to approximate by straps passing from the one to the other, by which means the fractured portions are maintained in a state of coaptation. A long hollowed splint should pass from the buttock to the heel, so as to prevent any motion of the limb. There is a difference of opinion, whether or not the patella is capable of ossific consolidation, or only of being united by ligamentous tissue. But it seems, from the experiments made by Sir Astley Cooper, as well as from the results of his experience in practice, that in longitudinal fractures, or even in transverse ones, when the ligamentous covering has not been torn through, that bony union may occur; while on the contrary, when the fractured portions are separated, ligamentous union is the only means of reparation, nor does the absence of ossific deposit appear to depend wholly upon the want of coaptation, but rather upon the inability of the vessels of the ligamentum patella to secrete bone, unaided by the blood-vessels of the patella itself.

Fractures of Tibia and Fibula.—Although there is such analogy between the bones of the leg and of the fore-arm, as to structure, yet there is this difference with respect to their fractures, that it most frequently happens, with respect to the leg, that both bones are broken, while in the fore-arm, it more usually happens that one only is fractured: the cause of this difference it may be well to mention, as it depends upon the different mode of their articulations. In the arm, the radius is most frequently fractured alone, because in a fall upon the hand, with which it is articulated, it receives the whole weight of the body, and communicates the impulse to the humerus and not to the ulna; while by a fall on the feet from any considerable height, the tibia in a like manner receiving the whole length of the body, gives way to the application of so great a force, which force continuing to operate, the fibula, now having lost the support of the tibia, is subsequently broken. They may, however, as happens to the bones of the fore-arm, be both broken at the same time, and parallel to each other, by a force applied directly on the part of the bones fractured, as when a heavy weight passes over the limb. When both bones are broken, a diagnosis is easily formed from the pain, loss of motion, altered form of the limb, and by crepitus being perceptible upon rotating the foot. The position of the fractured bones is generally angular, the upper portion being directed forwards and inwards, while the lower portion is drawn backwards and outwards, by the muscles of the calf of the leg. (*Vide Fig.* I., *Plate* X.) But longitudinal derangement very rarely occurs, in consequence of the extent of surface the fractured bones present, unless the fracture be very oblique, and then some slight shortening may occur. The treatment of fracture of both bones consists in making extension from the foot, and counter-extension from the knee; and usually by a very slight force coaptation is produced, which may be readily known by tracing the anterior angle of the tibia, which is so little covered by soft parts as to render the slightest deviation from the natural direction perceptible. While the limb is held in this position, a long well-stuffed pad should be adjusted on each side of the leg, so as to fill up all the natural depressions of the limb; over these the lateral splints are applied, which should be of sufficient length to pass beyond the foot, so that all the movements may be prevented; for it is by the motions of the foot that derangement of the fractured portions is most likely to recur. The splints are sometimes furnished with what is called the foot-piece, for the purpose of retaining the limb in its proper position, but the long splints do equally well. A third splint may be applied on the anterior part of the leg, which answers not only the purpose of keeping the bones in their proper position, but also forms a good defence to the leg, from the tapes which are applied for the purpose of permanently securing the splints. The limb may be placed either upon the side or upon the heel, in whatever position the surgeon finds best suited to the circumstances attending the accident: if upon the heel, great care should be taken that every part of the posterior surface of the leg is equally supported, which may be effected by means of bags of bran, or dossils of lint, and that the heel is neither elevated or depressed; for in the first case, the lower portion of the fractured bone would be thrown backwards; and in the second, it would form a salient angle forwards. The surgeon, upon subsequent examination, may always satisfy himself that the limb maintains its proper position, by attending to the direction of the great toe, which ought always to lie in a direct line with the centre of the patella. If concomitant with fracture there be laceration of soft parts, requiring daily examination, the limb should be placed in such a position, that the injured parts may be exposed without the necessity of moving the fractured bones; but, should this desirable object be unattainable, the apparatus should be so constructed as to allow the wounds to be exposed, and this may generally be effected by having the bottom of the fracture box, or the side splints, open upon hinges.

Fracture of the Tibia.—When this bone is fractured alone, the accident is more difficult to discover than when both bones are broken, in portions. But when there is reason to suspect this occurrence from a fall or a blow, the anterior angle is to be carefully traced, upon which the slightest inequality may be detected, and consequently the extent of the injury accertained. The fibula remaining whole, will not admit of sufficient separation of the fractured portions of crepitus to be produced; but the friction of these portions may be sufficiently diminished by extension and counter-extension, as to admit any slight derangement being corrected. The same treatment is to be followed as when both bones are broken.

Fracture of the Fibula.—If the fibula alone be fractured, and much tumefaction ensues, it is often difficult to detect it; more particularly as the patient is frequently able to walk after this injury. In whatever direction the bone may be broken, the pieces are not susceptible of a longitudinal darangement, but are always drawn inwards towards the tibia; *(Vide Fig. 2, Plate X.)* so that the best means of detecting this fracture is to press the fibula towards the tibia, when crepitus will be perceived. Fracture of the fibula is frequently produced by the foot being forcibly driven outwards during its progressive motion, so that the astragalus, striking violently against the malleolus externus, that portion of the bone gives way just where it is attached to the lower extremity of the shaft. In the treatment of fractures of the fibula, the outer splint should project beyond the foot, so as to prevent its rotation outwards.

The Foot.

The foot forms the third part of the lower extremity, is situated inferiorly with respect to the leg, which is attached to its upper surface at a right angle, nearer to its posterior than to its anterior extremity: it is composed of the bones of the *tarsus*, placed posteriorly; of the *metatarsus*, in the middle; and of the *phalanges*, in front.

The Tarsus,

(ταρσος the flat part of the foot.)

Forms the posterior middle part of the foot, and is composed of seven bones ;—the *astragalus, calcis, scaphoid, cuboid,* and three *cuneiform* bones, which are so articulated as to form an arch sufficiently strong to bear the whole weight of the body, and yet sufficiently elastic to prevent severe concussion.

The *astragalus* is the uppermost of the bones of the tarsus, and forms a superior projecting prominence, which is admitted between the malleoli of the tibia and fibula, to compose the ancle-joint. Immediately beneath this bone is placed the calcis, which reaches no further forwards than the astragalus, but projects considerably backwards to form the heel; those two bones are so connected with each other, that the astragalus is directed anteriorly to the inner side, while the calcis faces forwards to the outer edge of the foot; to the former is articulated the scaphoid, or navicular bone; and to the latter, the os cuboides. The scaphoid bone is so short as not to reach to the metatarsal bones; while, on the contrary, the cuboid bone does extend from the calcis to the metatarsal bones of the little toe and toe next to it; so that the space between the navicular and the three inner metatarsal bones is filled up by the three cuneiform bones. These tarsal bones, when thus connected, form an arch, the convexity of which is facing upwards on the dorsum of the foot, from before to behind, as well as from side to side; while, in the sole of the foot, a concavity is maintained in the same directions.

The Astragalus,

(αστραγαλος a die.)

This bone is divided into its *body*, *neck*, and *head*.

The body, *above*, presents a large articular surface, which is convex from before to behind, and slightly concave from side to side, for its attachment to the tibia: it is broader anteriorly towards the neck of the bone than it is posteriorly, so as to admit of lateral motion of the foot during its extension.

The *inner* surface of the body of the astragalus is divided, above, into an articular, and below, into a rough non-articular surface: the former, which is articulated with the internal malleolus, is large and rounded in front, and forms an acute termination posteriorly. The non-articular surface below, gives attachment to strong tarsal ligaments.

The *external surface* of the body forms a *larger* articular face than the inner, to be connected with the outer malleolus:

it is of a triangular form, with the base situated above, and the apex below; being slightly concave from above to below. The *posterior surface* is the smallest and thinnest portion of the bone; it presents to the outer side of its centre a small *tubercle*, which gives attachment to the posterior calco-astragalan ligament; and immediately to the inner side of this tubercle is situated a *sulcus*, which admits the passage of the tendon of the m. flexor longus pollicis. The *inferior surface* is hollowed out into a large articular depression, which is concave from behind to before, to connect it with the calcis: the circumference of this depression is rough for the attachment of ligaments.

The *neck* of the bone is directed from the body, with an obliquity forwards and inwards, to terminate in the head of the bone. The superior surface of the neck is rough, for the attachment of ligaments, which strengthen the articulation between the astragalus and navicular bone. Its *external* surface is longer than its *internal;* and inferiorly, this portion of the bone is formed into a deep sulcus, directed from behind to before, and from within to without, which, in the recent subject, is filled up by strong ligaments, to connect the astragalus and calcis.

The *head* of the astragalus is composed of an *anterior* and an *inferior articular process:* the *anterior* one, which is connected with the os naviculare, forms a considerable convexity from side to side, and is bounded by an irregular circumference for the attachment into ligaments: the *inferior* one, which has its long axis directed from behind to before, with some slight obliquity outwards, is common to the inferior surface of the neck, as well as to the head of the bone, and is destined to be partly resting on the astragalus, and partly on a strong plantar ligament.

Connexion.—The astragalus is connected above with the tibia and fibula to form the ancle-joint, below with the os calcis, and in front with the scaphoid bone.

Use.—This bone assists in forming the ancle-joint, receives the whole weight of the body from the tibia, and, by its articulation with the calcis and tarsal ligaments, it conveys the weight to the foot without producing concussion.

Attachment of Muscles.—The muscles attached to this bone are the tibialis posticus and the extensor brevis digitorum pedis.

The Os Calcis.

(Calco, to tread upon.)

This is the longest bone of the foot, and constitutes the base of support for all the other bones of the tarsus: it is of a very irregular form, and presents a *superior*, an *inferior*, an *external*, an *internal*, an *anterior*, and a *posterior surface.*

The *superior* surface presents, rather anterior to its c etre, two articular surfaces, which are separated fram each other by a deep sulcus, the direction and form of which correspond with the under surface of the astragalus. Behind these articular surfaces is situated the upper part of the great projecting protuberance, forming the heal, which, on this aspect, presents a surface cancave from before to behind, and convex from side to side. Anteriorly to the outer side of the smaller articular surface, but immediately in front of the larger one, the bone is roughened for the attachment of the superior calco-cuboidal ligament, and origin of the m. extensor brevis digitorum communis.

The *inferior* surface of the calcis is smaller than the superior, and presents an irregular concavity from behind to before, assisting to form the longitudinal arch of the foot. On its posterior part are placed two tuberosities; the larger one on the inner side, and the smaller on the outer: they give attachment to the m. abductor pollicis, flexor brevis digitorum communis, and the abductor minimi digiti.

The *anterior* surface is formed entirely of an articular face, which is somewhat triangular, and concave from above to below, to be connected with the cuboid bone.

The *posterior* surface is convex from above to below, as well as from side to side; presents, above, a smooth flattened triangular surface, pointing out the position of a bursa, between the bone and the tendo-achillis; below, it is rough for the firm attachment of the tendons.

The *external* surface, which is flat and much larger posteriorly than it is anteriorly, is marked in its middle, immediately below its posterior and superior articular surface, by a groove for the passage of the tendons of the peronei muscles,; immediately below which groove is placed a small tuberosity for the insertion of the external lateral, or perpendicular calco-fibular ligament.

The *internal* surface is large, and concave from above to below, to lodge the tendons of the m. tibialis posticus, flexor longus digitorum communis, and the flexor longus pollicis pedis; and also the vessels and nerves passing to the sole of the foot. A slight protuberance may be seen upon the middle of the posterior part of this surface, for the origin of the m. accessorius; and on the anterior and upper part, a sulcns, to lodge exclusively the tendon of the flexor longus pollicis.

Connexion.—The os calcis is articulated above with the astragalus, and in front with the os cuboides.

Attachment of Muscles.—The m. extensor brevis digitorum, to the anterior part of the *upper* surface; to the *under* surface, the m. abductor, flexor brevis, and adductor pollicis, flexor brevis digitorum, and abductor minimi digiti; to the *inner* surface, the flexor digitorum accessorius; and the tendo achillis is inserted into its tuberosity.

The Navicular, or Scaphoid Bone.

(Navicula, vel σκαφη a boat.)

This bone is somewhat circular in form, is placed on the inner side of the middle of the foot, and presents an *anterior* and *posterior* articular surface, a *dorsal* and *plantar* non-articular aspect, and an *internal* and *external* extremity.

The *anterior* articular surface is covered with cartilage, is slightly convex from side to side, are presents three distinct faces for the articulation of the three cuneiform bones; the two outer of these faces are larger above than they are below, while the inner is larger below.

The *posterior* articular surface forms an oblong concavity, to receive the astragalus.

The *superior,* or *dorsal* aspect, is convex from side to side, and rough for the attachment of ligaments.

The *inferior,* or *plantar* surface, is also rough, but irregularly concave from side to side, to maintain the transverse arch of the foot.

The *inner extremity* forms a projecting tubercle, to which is attached the abductor pollicis, in part, and the tendon of the m. tibialis posticus; and also the strong plantar ligaments.

The *outer extremity,* at its upper and posterior part, presents a small *articular* surface, where it is connected with the cuboid bone.

This bone does not reach the metatarsal bones, but a space is left between them and the navicular, for the three cuneiform bones.

Connexion.—The os scapoides is articulated behind with the astragalus, on the outer side with the cuboid, and in front with the three cuneiform bones.

Attachment of Muscles.—The m. tibialis posticus is partly inserted into the under surface of this bone, and the abductor pollicis partly arises from it.

The Three Cuneiform Bones,

(Cuneus, a wedge.)

Are placed so as to be articulated, behind, with the navicular, in front, with the metatarsal bones, supporting the three inner toes; and externally, with the cuboid bone.

The Internal Cuneiform Bone

Is the largest of the three, is of an irregular prismatic form; its *base* situated below, and its apex above; it presents a *posterior articular* surface, concave from side to side, which is connected with the navicular bone, and an *anterior,* plain, articular surface, lengthened from above to below, to join it with the metatarsal bone of the great toe. Its *external* surface is concave, and presents two *articular* faces, a *posterior* one which is placed vertically, to be connected with the middle cuneiform bone, and to the *anterior* and *superior* horizontal face; the metatarsal bone of the second toe is articulated. The *internal surface* is scabrous, and is furnished with two tubercles, which give partly origin to the m. abductor pollicis, and insertion to the tibialis anticus. The *apex* is situated on the dorsum of the foot, and is directed obliquely from behind to before, is rough, and gives attachment to ligaments. The *base*, which is placed in the sole of the foot, is also rough for the firm connexion of the plantar ligaments.

Connexion.—This bone is connected behind with the navicular, externally, with the middle cuneiform and metatarsal bone of the second toe, and in front with that of the great toe.

Attachment of Muscles.—The m. tibialis anticus, posticus, and peroneus longus, are inserted into it.

The Middle Cuneiform Bone

Is the smallest of the three; it is situated at the anterior part of the middle of the tarsus, and is divided into *four articular surfaces*, a *base*, and an *apex*. Its *posterior* articular surface is concave, and broader above than below, to be articulated with the middle part of the os naviculare. Its *anterior* surface is convex, and is articulated with the posterior extremity of the metatarsal bone of the second toe. The *internal* face has a smooth flat surface above and behind, by which it is in contact with the internal cuneiform bone; and a small rough fossa below, for the attachment of ligament. The *external* surface is slightly hollowed, where it is contiguous to the external cuneiform bone.

The *base* is nearly quadralateral, but rather longer than broad, slightly convex from side to side; is situated on the dorsum of the foot, is rough and penetrated by numerous foramina.

The *apex* is very thin, passes into the sole of the foot, and assists, from its wedge-like form, in producing the transverse arch.

Connexion.—This bone is articulated behind with the navicular, before with the metatarsal bone of the second toe, on the outer side with the external cuneiform, and on the inner with the internal cuneiform bone.

Attachment of Muscles.—The m. tibialis posticus is partly attached to this bone.

The *middle* cuneiform bone is so much shorter than either of the others as to form a deep cavity for the articulation of the second toe, and leading to considerable difficulty in the amputation of the metatarsus from the tarsus.

The External and Cuneiform Bone.

In shape it somewhat resembles the preceding, but is longer from before to behind; it is larger than the middle, but not so large as the internal cuneiform bone; it has its *base* placed above, and its *apex* below, and presents five *articular surfaces.*

Its *base,* or superior surface, is rough, longer than it is broad, and forms a part of the dorsum of the foot.

Its *apex,* which is thin, passes into the sole of the foot.

The *anterior* articular surface is flat and smooth, to be connected with the metatarsal bone of the third toe.

The *posterior* face is inclined somewhat inwards, to be articulated with the navicular bone.

The *internal* surface presents two articular faces; the posterior one the larger, which is connected with the middle cuneiform bone, while the anterior one receives a portion of the metatarsal bone of the second toe; and between these two articular surfaces, the bone is rough for the attachment of interosseous ligaments.

The *external* surface presents a large rounded articular face, by which it is joined to the cuboid bone.

Connexion.—Behind, with the os naviculare, externally, with the cuboid, internally, with the middle cuneiform and second metatarsal bone, and in front, with the metatarsal bone of the third toe.

Attachment of Muscles.—The m. flexor brevis and abductor pollicis pedis, and part of the tibialis posticus (which is attached to all the cuneiform bones), are connected to the os cuneiforme externum.

Os Cuboides,

(κυβος a cube, ειδος resemblance.)

This bone is situated at the anterior and outer part of the tarsus, being placed between the calcis and metatarsal bones of the fourth and fifth toes.

The *superior* surface of this bone is broad, rough, and directed obliquely outwards, forming a considerable portion of the outer edge of the tarsus. Its *inferior* surface is divided into two by a deep *sulcus*, which is directed from without to within and from behind to before, and lodges the tendon of the peroneus longus. The portion of bone anterior to this groove is rough, for the attachment of ligaments connecting the cuboid with the metatarsal bones; and posterior to the groove, a considerable protuberance is formed for the insertion of the inferior platar ligament.

The *anterior* face presents an articular surface, which is directed from within to without, and from before to behind, divided into two parts, for the articulation of the fourth and fifth toes.

The *posterior* face is convex from above to below, and slightly concave from side to side, to be articulated with the calcis. The *internal* face has two articulatory surfaces: the larger flattened anterior one, to connect it with the external cuneiform, and the posterior, for its junction with the os naviculare. The *external* face forms a thin edge, which, in its centre, is furnished with a notch, marking the situation of the groove for lodging the tendon of the peroneus longus muscle.

The human subject only, walks with the whole foot on the ground. In the quadrumina, and plantigrades, which form the first five genera of Blumenbachs feræ, the os calcis does not touch the ground.

The tarsus of the horse and ruminantia, is placed about midway between the body and the hoof, and forms what is termed the hock of those animals.

Attachment of Muscles.—The m. abductor pollicis pedis, and flexor brevis minimi digiti, are attached to the cuboid bone; and sometimes the flexor brevis pollicis pedis.

The Metatarsal Bones

Form the second division of the bones of the foot. They are five in number, and are placed between the tarsus and the toes: their form is cylindrical, and are thicker at their two extremities than in the centre.

The first, or metatarsal bone of the great toe, is the thickest, but the shortest of the five: it is divided into a *posterior* or *tarsal*, and an *anterior* or *digital* extremity; and a *middle* part, or *body*.

The *tarsal extremity* presents a concave articular surface, which is divided into a large superior and a smaller inferior portion, to be connected with the internal cuneiform bone; the circumference of this extremity is semilunar in form, being flattened *externally*, where it is connected with the metatarsal bone of the second toe; convex and rough *internally*, for the attachment of ligaments; the *inferior* surface presents a tubercle, into which the tendon of the peroneus longus is inserted.

The *body* of the bone is triangular and contracted. Its superior surface is convex, both from behind to before and from side to side. Its *inferior* surface is concave from behind to before, to preserve the longitudinal arch of the foot. The *external* surface is hollowed out, particularly in its centre, so as to leave a considerable space between it and the metatarsal bone of the second toe. The *internal* surface is flattened.

The *anterior*, or *digital* extremity, is also called the *head* of the bone, and forms a large, rounded, smooth, articular surface, which is articulated with the first phalanx of the great toe. On the inferior surface of the head are placed two small *articular depressions*, separated from each other by a slight projection of bone, which lodge the two sesamoid bones proper to the first tarso-phalangeal articulation. The circumference of the head is rough, for the attachment of the capsular ligament, and the sides are furnished with two small tubercles, to which are attached the lateral ligaments of the joint.

The *metatarsal bone* of the *second toe* is the longest of the whole, and passes backwards into the tarsal region, between the internal and external cuneiform bones, to be connected with the middle cuneiform bone.

Its *tarsal* extremity presents a posterior concave articular surface, to be joined with the middle cuneiform bone. Laterally and externally, two articular surfaces are placed; a posterior one, by which it is joined to the external cuneiform bone, and an anterior one, which connects it with the metatarsal bone of the third toe. Internally, the head presents one flat surface, for its junction with the internal cuneiform bone.

The *body* of this bone offers nothing remarkable.

The *anterior extremity*, or *head*, presents an articular surface, more extensive above, than either below or latterally, and is articulated with the first phalanx of the second toe; the circumference of the head is rough, and furnished superiorly with a deep sulcus for the attachment of the capsular ligament.

The *metatarsal bone* of the *third toe* is the next in length of the bones of the metatarsus. Its *tarsal extremity* presents a flattened surface, which is directed with some slight obliquity from within to without, to be connected with the external cuneiform bone. It is joined internally with the metatarsal bone of the second toe, and externally with the metatarsal bone of the fourth toe.

The *body* and *head* of this bone resemble so much the description of the last, as to require no further explanation.

The *metatarsal bone* of the *fourth toe* is nearly as long as the former. The *tarsal* extremity of the bone, posteriorly, is furnished with an oval articulatory surface, somewhat elevated in the centre, and is connected with the cuboid bone. Its internal face is joined to the metatarsal bone of the third toe, and externally it is in contact with the metatarsal bone of the fifth toe. The *body* and *head* of this bone are similar to the second and third.

The *metatarsal bone* of the *fifth toe*, at its posterior or tarsal extremity, presents a regular convex articular surface, inclined inwards, which is articulated with the cuboid bone; while the outer extremity forms a protuberance which projects behind and externally to its articulation with that bone. Anterior to the face for its articulation with the cuboid bone, is situated a small articulatory surface, for its connexion with the metatarsal bone of the fourth toe. The *body* of this bone presents a superior surface, which is convex from within to without; its *head* offers nothing remarkable.

The five metatarsal bones are so connected with each other, and the bones of the tarsus, as to form a convexity from side to side on the dorsal aspect, and a concavity from side to side in the plantar region.

The structure of the metatarsus in the horse and the ruminantia is similar to that of the metacarpus, being very much lengthened, so that these animals bear their weight upon their toes.

Attachment of Muscles.—Muscles arising common to the metatarsus are the m. interrossei, and transversus pedis; the adductor pollicis pedis, from the second, third, and fourth; and the flexor brevis, and abductor minimi digiti pedis, from the fifth metatarsal bone.

Muscles inserted into the metatarsus, are the tibialis anticus, peroneus longus, and adductor pollicis pedis, into the first; tibialis posticus, into the second and middle; the peroneus brevis and tertius, and the flexor brevis, and abductor minimi digiti, into the firth metatarsal bone.

The Toes

Form the third division of the bones of the foot, and are five in number. They are composed of fourteen bones termed *phalanges:* each of them being furnished with three of these bones, excepting the great toe, which has but two, as the great toe wants its middle phalanx. The phalanges are classed as the *posterior*, *middle*, and *anterior row*.

The *posterior* or *first phalanges* of the toes are longer than the others, and present a body and two extremities, The *posterior* extremity is furnished with a semilunar concave articulatory surface, which receives the head of the metatarsal bones; and on their plantar surface a *sulcus* is seen, which is directed from behind to before, covered with cartilage, and lodges the flexor tendons of the toes. The lateral parts of this extremity are each formed with a tubercle, to give attachment to the lateral ligaments. Their *anterior* extremity presents two articular apophyses or condyles, which are separated from each other, more inferiorly, than superiorly, by a sulcus. They are connected with the posterior extremities of the second phalanges. The *bodies* of the first phalanges form a convexity from behind to before on their dorsal surface, a concavity from behind to before on their plantar surface, and are contracted in the middle.

The *middle* or *second phalanges*, of which there are but four, the great toe not having one, are very short, being nearly square. Their *dorsal* surface is concave from behind to before, and convex transversely. Their *plantar* surface is also concave from behind to before. Their *posterior* extremity presents an articular depression, divided into two parts by a middle projection, which is directed from above to below, and is articulated with the anterior extremity of the first phalanx. The *anterior* extremity presents an articular surface, exactly corresponding to the depression of that of the first phalanx.

The *extreme* or *third phalanges* are very small, excepting that of the great toe, which is of considerable size. Their figure is pyramidal; their superior and inferior surfaces are concave from behind to before, and are roughened for the attachment of tendons. Their *posterior extremity* is furnished with an articular cavity, similar to the posterior articulatory surfaces of the second phalanges. Their *anterior extremity* is rounded and scabrous, more especially on the dorsal surface, for the attachment of the condensed tissue which secretes the nail.

The carnivora are furnished with five toes parallel to each other, and on which they rest and walk. The simiæ, instead of having the great toe placed parallel with the others, are furnished with a thumb, and are to be considered therefore as quadruminous.

The horse has but one toe furnished with three phalanges, on the inferior of which he bears his weight, and to which the hoof is attached, so that he may be considered as standing on the nail. The upper phalanx of this toe is termed the great pastern, the middle one the less pastern, and the lower one the coffin bone.

Attachment of Muscles.—Muscles common to the phalanges are the m extensor longus et brevis digitorum pedis, and interossei, inserted into all their dorsal surfaces: into their plantar surfaces are inserted the flexor longus digitorum pedis into the third phalanges, the m. flexor brevis into the second, and the m. lumbricales into the first. The muscles proper to the great toe are the m. flexor longus et brevis, abductor, adductor, and extensor longus pollicis pedis; and to the little toe, the flexor brevis and abductor minimi digiti pedis.

Ossa Sesamoidea.

(σησαμη a seed.)

These bones have derived their name from their form: they are small bones, placed in certain articulations of the toes and fingers. Their number, size and situation vary in different individuals, but seem to bear a proportion to the developement of the muscular system. The sesamoid bones, at the articulation of the first phalanx of the great toe with the metatarsal bone, are seldom wanting; they are not only for the purpose of giving attachment to muscles, but also to increase their power of action. The sesamoid bones have been supposed to be formed in consequence of pressure; but this stimulus does not seem to be necessary to their developement, as they are frequently found in the fœtus a few months after conception.

Practical Remarks.

The bones of the foot are but little liable to fracture in consequence of their conformation, their mode of articulation with each other, and their structure: indeed, all those circumstances which have already been stated as tending to prevent fracture of the bones of the hand, apply equally to the bones of the foot, if we except the os calcis; while this bone, from the manner in which it projects backwards, to receive the insertion of the extensor muscles, is liable to solution of continuity, either from the sudden contraction of the gastrocnemii muscles, or the application of external violence. It is much more frequent, however, for the tendo Achillis to be ruptured, than for the bone to give way when influenced by the inordinate action of the muscles.

Fracture of the Os Calcis.

Although the os calcis is, of all the bones of the tarsus, the most likely to be fractured, still, the dimensions of the bone in every direction are so nearly equal, that it is a rare occurrence to meet with the accident; but Boyer recites examples of these cases, both from the action of muscles, and from falling on the foot from a considerable height. The nature of the accident may be known by swelling and pain following a fall on the sole of the foot, the pain being much increased by motion; the inability to walk or move the foot, and by a crepitus being perceptible if the projection of the calcis be moved upon the body of the bone. Separation of the fractured portions is not very readily ascertained, in consequence of the thickness of the integuments of the foot.

The treatment of this accident consists in extending the foot and flexing the knee, by which position of the limb, the tendo Achillis is completely relaxed: indeed, the treatment is much the same as in rupture of the tendo Achillis, excepting that some pressure is required from behind to before, to keep the fractured portions in more complete apposition.

The other bones of the tarsus are only liable to comminutive fracture, and the same may be said of the bones of the metatarsus and phalanges.

Observations upon the general Treatment of Fractures.

In the treatment of all fractures of the long bones, two great points are to be attended to:—First, to bring the fractured portions in contact; and, secondly, to retain them there. It is frequently a matter of very great difficulty to answer the first intention, in consequence of the action of muscles; it is, therefore, essential to relax as much as possible the muscles attached to the fractured bone, which is effected by semiflexing the joints of which the injured bone forms a part. It should be remembered, however, there are some deviations from this general rule, as in fractures of the olecranon, and patella; in which cases, it requires permanent extension of the limbs, to produce relaxation of the muscles influencing the fractured bones.

There are also other circumstances which are to be considered by the surgeon, before any general rule of treatment can be laid down, such as the class of bone subjected to the accident; bearing in mind, that the *flat bones*, when fractured, are but little influenced by muscles, and that the danger which ensues, is depending upon the degree of injury done to the important organs contained in the cavities formed by this class of bones, as in the head and pelvis: and that the object of the surgeon is to avoid any subsequent ill effects, by strict attention to the antiphlogistic regimen, and perfect rest.

The *short bones* are, as has been before remarked, but little liable to fracture, in consequence of their form, and spongy texture; and that, when broken, the soft parts have usually suffered so much from contusion, that the surgeon's attention is more directed, first to subdue the inflammation, than to replace the bone. Fracture of these bones is, moreover, dangerous from their vicinity to joints, and also from the greater quantity of animal matter that enters into their composition, rendering them more liable to subsequent inflammation and disease.

Compound fracture differs only from simple in there being an external wound communicating with the fractured extremity of the bone, by which, indeed, the wound is generally produced. The treatment differs but in removing every extraneous substance and portions of bone if it be comminuted fracture, then closing the wound, and assisting nature in every way to convert it into a simple one. The means to be adopted to relax the muscles, and to keep the bones in their natural position, is precisely the same in compound as in simple fracture; unless, indeed, the situation of the wound of the soft parts, renders it necessary to place the fractured limb in a position, which would not otherwise be chosen, but for the facility of dressing the wound without the necessity of moving the fractured bones.

Immediately after fracture of any bone in which there is a tendency to great tumefaction, it is wrong to apply either splints or bandage, for any restriction of swelling is liable to produce gangrene: under these circumstances, the limb should be placed on a pillow in a semiflexed position, so that the muscles may be perfectly relaxed, and the bones placed as near as possible in their natural position; which circumstances may be ascertained, whatever may be the swelling, by the immediate comparative ease of the patient. An evaporating lotion is then to be used; or should there be any tendency to involuntary contraction of the muscles, strips of soap-plaister may be gently applied around the limb, which, by causing a secretion beneath it, diminishes the irritability of the muscles, as well as the urgency of the inflammation. If it can be avoided, purgative medicines should not be given, as they would produce a necessity for frequent change of position; but should their use be considered essential, such medicines should be given as are least likely to keep up a continued action on the bowels. As soon as the tumefaction and inflammation have subsided, which, under the treatment recommended, generally happens in three or four days, well padded splints should be applied, and retained in their situation by broad pieces of tape resting firmly on the splints, but should not any where be in contact with the limb.

It has been stated, that a bandage should never be applied immediately after the occurrence of fracture: however, it may be considered as an exception to this rule, that when a portion of fractured bone has wounded and irritated a muscle, a bandage is the best means of relieving its spasmodic action. When fracture of a bone happens in the neighbourhood of, or passes into a joint, local bleeding, by means of leeches, is always necessary, and may require frequently to be repeated: even the necessity for general bleeding may sometimes be indicated, when there is much constitutional irritation; in which case, calomel and opium will also be found of the greatest service. In fractures into joints, when inflammation becomes so violent that the surgeon sees that anchylosis must necessarily occur, the joint should be placed in such a position, as to render the limb as useful as possible. Under these circumstances, for instance, if the elbow-joint be the one affected, the fore-arm should be semiflexed; by which position the patient will be afterwards able to feed himself. In the knee-joint, the leg should be very slightly flexed upon the thigh; by which method, he is better able to direct the foot, and the limb is rendered more manageable in the sitting posture. In the ancle-joint, we should endeavour to procure a union with the foot perfectly flat; whereby the patient will afterwards enjoy very considerable use of the limb.

Fractures of the Flat Bones.

Injuries of the Head.—In simple fractures of the cranium, little is required of the surgeon, as the danger and importance of the accident arises from the probability of injury to the important and vital parts they inclose: hence the necessity of strict attention to the antiphlogistic regimen, and rest. The consequence of a severe blow on the head, is frequently either *concussion* or *compression* of the brain.

In *concussion* the brain is merely shaken, and is neither lacerated nor compressed, and may be ascertained by the following symptoms:—The patient appears stunned, his pulse weak and fluttering, the face pale, and the extremities cold—such occurs immediately after the accident; but in a short time re-action commences, and a new form of symptoms presents itself. The patient now remains in a half comatose state, with his senses weakened, but not lost; his power of volition suspended, but not destroyed. If he be addressed loudly by his name, he is capable of giving a rational answer; and when thus roused, his pulse is found to rise from its natural number to a hundred and twenty: the pupils of the eyes, in simple concussion, have a natural appearance, and are capable of being stimulated by light: nausea, and even vomiting, are frequently concomitant symptoms. It is undecided, whether concussion be produced by venous congestion on the brain; but this can hardly be considered to be the case, as it is known that vomiting frequently restores the sense of the patient, which must necessarily have a tendency to increase the flow of blood to the head.

Of Compression.—Compression, which not unfrequently follows concussion, is known by the patient being quite comatose, his senses and volition being totally lost. The pulse is small, hard, and generally irregular, sometimes even intermitting: the pupils are dilated, the retina being no longer sensible to light; it however sometimes happens, that one pupil will be contracted, whilst the other is dilated. The breathing is stertorous. When the injury is very severe, hemiplegia is produced, and most frequently on the opposite side to which the injury had been received. These various symptoms may arise either from bone pressing upon the brain, from extravasation of blood, or from the formation of matter. If from the first cause, the symptoms will come on immediately after the accident; and upon examination, if the finger be steadily pressed upon the part, irregularity of the bone may be detected; and the more firm the pressure, the more distinctly will be felt the edge of the fractured bone. This circumstance is mentioned, as swelling of the scalp communicates a feeling as if the bone were depressed; but in this case, if the pressure be made firmly, the sensation of depression immediately ceases. If extravasation be the cause, the symptoms, as enumerated, come on gradually after the accident: sometimes hours, and even days, elapse before they are fully developed, depending upon the size of the vessel that is ruptured. And lastly, wheh matter forms, days and even weeks may supervene before the accession of the symptoms, and they are always preceded by inflammatory action, by sickness and rigors. With these symptoms, which too frequently but insidiously progress, unattended with pain, the surgeon is led most attentively to examine the scalp over the seat of the injury, where a puffy appearance will sometimes point out the situation of the mischief. If there happen to have been a wound, the formation of matter may be more clearly defined; as now, however healthy its appearance might have been before, it puts on an unhealthy aspect; the granulations become glossy, and the discharge thin and ichorous.

Treatment of Concussion and Compression.

In both concussion and compression, as soon as re-action had taken place, large quantities of blood should be taken from the jugular vein or temporal artery; the quantity, however, must depend upon the powers of the patient. A dose of calomel should be immediately given; which if the patient cannot swallow, should be passed into the fauces, mixed up with butter; and in an hour after, small doses of the sulphate of magnesia should be administered: a sinapism should be applied to the soles of the feet; the head should be shaved; and if the symptoms be not relieved by cold applications, a blister should be applied to the scalp. If all these means fail, under what circumstances are we to trephine? If there be a wound communicating with the bones of the skull, accompanied with fracture and depression, in such cases, although no untoward symptoms have yet arisen, we are recommended immediately to trephine; but of the propriety of this step there seems to me some doubt. We should rather be led to judge of the necessity for the immediate application of the trephine by the *degree* of depression, and by the *part* of the skull injured; for as the quantity of diploe differs so much in different skulls, there is no evidence of the brain being injured until symptoms supervene; and I would therefore recommend that the patient should be most narrowly watched, and that the trephine should not be applied until symptoms point out the necessity. When compression occurs from the formation of matter, which, as already mentioned, does not come on until some time after the accident, the surgeon is placed under the greatest difficulty to discover the precise seat of the injury, as it is not always at the part where the blow was inflicted. To ascertain this essential point, the scalp must be most carefully examined, and if a puffy appearance be found opposite to the part where the matter is situated, an incision is to be made through this part of the skull exposed, which will be found denuded, or at any rate its pericranium easily separable from it: the bone itself will be of an ash colour, without any tendency to bleed. These circumstances will prove that you are justified in removing this portion of bone. I have seen my colleague and relative, Mr. Key, under these circumstances, perform this operation with perfect success as far as refers to the evacuation of the matter, although the patient did not subsequently recover, in consequence of the extent of injury the brain had sustained.

The fractures of the bones of the pelvis, need no further account than has already been given with the description of the individual bones.

LECTURES ON ANATOMY.

PART II.

PARTS ESSENTIAL TO THE SKELETON.

LECTURE V.

PARTS ENTERING INTO THE COMPOSITION OF JOINTS.

In treating of articulations it will be necessary, in the first place, to give a separate consideration to each of the parts and structures which enter into their composition; for, although in cutting into a healthy joint, bone is not exposed, yet the first great character of a moveable articulation is the approximation of two or more bones, so far fitted to each other as to be rendered capable of performing its various functions by the addition of *cartilage, synovial membrane,* and *ligaments;* and these structures, although subservient, tend to strengthen the articulation, and to give freedom and ease to its motions.

Cartilage.

Cartilage represents a solid, polished and very elastic substance, of a pearly whiteness, or opalescent; it is slightly flexible, less hard and lighter than bone, but, excepting bone, offers more firmness than any other structure in the body. In texture its fibres are very indistinct, being scarcely perceptible. This homogeneous appearance is in consequence of the great quantity of animal matter which enters into its composition, and from the small quantity of cellular membrane which connects its fibres; but by masceration or boiling, its fibrous and laminated texture may be demonstrated.

In a state of health, no *blood-vessels* can be traced into cartilage, because they circulate only the colourless parts of the blood; but under inflammation, or if there be a tendency for the cartilage to be converted into bone, immediately these vessels circulate the red particles of the blood, and they become visible. The ramifications of *nerves* and *absorbents* are also too small to be perceptible, but the existence of both cannot be doubted as essential to the growth and developement of the system; indeed, the diseases to which it is liable, prove they enter into its composition.

The chemical analysis of cartilage resembles bone in being composed of animal matter and phosphate of lime; but it is in the proportions of these two substances that they differ. According to Sir Humphry Davy, cartilage consists of 44· 5 albumen; 55· water; and ·5 of phosphate of lime.

Gelatine is also found in cartilage as well as albumen, so that it is partly soluble in water at the temperature of 106°, but some fibres remain coagulated. The redness which appears on the surface of cartilage during maceration is considered, by Berzelius, to depend upon an oxide of iron; but Rudolphi believed it to be blood, as he found it more abundant in the young than in the adult subject, and quite absent in old age.

Cartilage is usually found disposed in a layer; very thin in proportion to its length and breadth, and is covered by a fibrous membrane called perichondrium, excepting some of the articular cartilages, which on the one surface is connected with bone, and on the other with synovial membrane. Cartilages are divided into two distinct classes, the *temporary* and *permanent*.

The *temporary* cartilages are found most abundant at the earliest periods of life, and diminish by their conversion into bone as the osseous system becomes developed; and, when completed, the temporary cartilages disappear. This class of the cartilaginous system is to be considered as essential to the production of bone; whether for its original formation, for its reparation after injury, or for its accidental growth.

The *permanent* cartilages, on the contrary, in health do not vary in number during the different epochs of life: not being, like the temporary, convertible into bone; but they maintain all their physical properties, for the purpose of assisting in the performance of the functions of those organs of which they form a part, subjected only to the changes common to all structures in the advancement to old age.

Permanent cartilage is found in three situations in the animal economy:—First, when it forms distinct organs, as the trachæa and larynx: secondly, where it enters into the compositions of articulations; and, thirdly, where it lines depressions in the bones, for the purpose of facilitating the motions of tendons. Of the first and third kind I shall not now treat, but leave them for more minute description when speaking of the particular parts to which they belong.

Articular Cartilages.

From what has already been said of the physical properties of cartilage, more especially from its elasticity, we should expect to find it in those situations most subjected to pressure, concussion, and contortion; hence it occurs between all the connecting surfaces of bones, to a greater or less extent, as they are subjected to these contingencies; and, morever, we find that these cartilages differ both in structure and form, according to the kind of motion to which they are subservient. It becomes, therefore, necessary to subdivide articular cartilages into *four classes:—First,* when it covers the articulatory processes of those bones admitting of the greatest extent of motion, and subjected to the most pressure; having one surface so firmly connected to the bone, that it seems as a continuous structure, deprived of phosphate of lime; whilst its other free or articular surface is covered by synovial membrane, which separates it from the cartilage of the corresponding bone entering into the joint. The texture of these cartilages consist of fibres, passing in the same direction as those of the bones from which they emanate, and becoming softer towards their free or synovial extremities.

The *second* class of articular cartilages is comprehended in those which connect the edges of flat bones, and which admit of no greater extent of motion between them, than their yielding nature will allow. These cartilages have two of their surfaces continuous with the bones which they connect, while the rest of their surfaces are covered with perichondrium. In this class the sutural cartilages of the bones of the skull are comprised, as well as those connecting the bones of the pelvis. All of them are of a wedge-like form, having their external surface larger than the internal.

The *third* class of articular cartilages may be considered as intermediate between the other two, and constitutes the medium of connexion between the ribs and the sternum. Here we find the cartilage emanating from the extremity of the rib, passing forward in the same form as the rib itself, and continued in the same direction towards the sternum, to which bone it is joined by the intervention of synovial membrane. From the great length to which it is prolonged, what would constitute its surfaces in the two first classes, are here converted into its extremities. Thus it will be found to resemble the first kind, by having one of its surfaces, or rather extremities, continuous with bone, while the other is covered with synovial membrane; and it is also analogous to the second kind, in being covered with perichondrium, and allowing of motion, from its elastic and yielding structure.

The *fourth* class are termed the inter-articular cartilages, which differ from the rest in not being in contact with the osseous system, but having both their surfaces covered by synovial membrane, and thus dividing the joint to which they belong into two synovial cavities. These cartilages are more fibrous than any of the other class, and are for the purpose of adapting their articulatory surfaces to the varied motions of the bones between which they are placed, to the extremities of which they always present a corresponding surface.

Practical Remarks.

The slowness with which the vital principle of cartilage manifests itself, the little tendency it has to be acted upon by morbid causes, and the slight power which it possesses of reparation, all render it liable to but few of the diseases which are incident to more highly organized structures. We therefore find that wounds in cartilage do not unite, like most of the other structures of the body, by the re-union of their surfaces, but that an intermediate ligamentous structure forms the bond of union between the divided edges. Temporary cartilages, however, when wounded, unite by bone. This incapability of generating permanent cartilage is further obvious in cases of unreduced dislocations, in which we find that nature has been able to reproduce all the structures necessary to the formation of a new joint, excepting articular cartilage; for, although cartilage may be formed during this progress of reparation, it is only of the temporary class, which is yet destined to be converted into bone. When the articular cartilage of a joint is destroyed, anchylosis usually follows. The permanent cartilages of the first class are more highly organized, and are not unfrequently found converted into bone, which we have opportunities of seeing in the cartilages of the larynx and trachea; and, under these circumstances, they become liable to the diseases of bone, as necrosis and exfoliation. We should, however, observe, that the permanent cartilage of the nose, eye and ear, are not liable to this ossific change; but they ought to be considered as belonging to fibro-cartilaginous tissue, of which I shall hereafter speak. *Accidental* formation of cartilage sometimes occurs in different structures of the body, and these have always a tendency to become ossified.

Synovial Membrane.

This structure enters into the composition of all moveable joints, and is for the purpose of secreting a fluid to lubricate their surfaces; but as its use is to obviate the effects of friction, it is also found where tendon or muscle is passing over bones. These membranes form closed cavities, without any external opening, accurately adapting themselves, by the attachment of their outer surface, to the parts which they are destined to lubricate; while its internal secreting surface forms the interior of the *joint*, and limits its extent; for of those which belong to muscles and tendons, I shall not speak until describing those structures. The structures of these membranes seem to be a modification of the common cellular tissue, rendered dense, transparent, and extensible. It is very vascular, and although neither nerves or absorbents have been traced to it, their existence cannot be doubted. In many of the joints it has a tendency to form folds, projecting into the general cavity, and containing small globules of fat between its layers, which, being of a reddish colour, have by some been incorrectly considered of a glandular structure: they seem, however, to be nothing more than formations of fat, for the purpose of adapting more perfectly to each other the parts which constitute the joint.

The synovial capsules of joints do not correspond in number to the articulations, since it is found that one synovial capsule is frequently subservient to several articulatory surfaces.

Synovia.

The secretion which is produced by the synovial membrane, is so called from its resemblance to the white of an egg; it is poured out from the extremities of the vessels, which terminate upon the internal surface of the membrane; and as this also possesses an absorbent power, the quantity of fluid under ordinary circumstances is limited to a healthy standard. When synovia is in a healthy state, it is transparent, of the consistence of albumen, very viscid, and upon being agitated entangles a considerable quantity of air; it is heavier than water, its specific gravity being 105. Its chemical analysis, according to Sir Humphry Davy, is as follows:—100 parts of synovia contain—

98 3	water.
·93	gelatine and mucilage.
·53	albumen.
·23	muriate of soda.
—	traces of fixed alkali and phosphate of lime.
100	

It has been a point of considerable dispute among physiologists, whether the synovial membranes should be ranked amongst the serous or mucous structures; and, indeed, this discrepancy appears to depend on the membrane partaking in some respects of the nature of both these systems. It resembles the serous membranes, from its forming a closed cavity, from its presenting at once a secreting and absorbent surface, from its extensibility, and from the manner in which it attaches itself to the parts that it covers. It is analogous to the mucous membranes in the consistence of its secretion, and from the pathological fact of its tendency to take the ulcerative, rather than the adhesive inflammation. In my opinion, however, they ought not to be considered as belonging to either class, but as forming a distinct system of their own. The function of synovia is to diminish the friction of the parts, and consequently to facilitate the motion of bones upon each other.

Practical Remarks.

One of the most frequent effects of inflammation of the synovial membranes, is the abundant secretion of its fluid, distending the joint, and producing the disease which is termed hydrops articuli. This disease is sometimes attended with pain; at other times, a considerable accumulation may take place, with little or no inconvenience to the patient. It depends upon the circumstance, whether it be a diseased action of the arteries or of the absorbents. In the first case, swelling and pain are invariable symptoms; while in the second, there being no increased action of the arteries, but a disease of the absorbents only, the accumulation occurs without suffering. Similar symptoms attend the accumulation of fluid in the large serous cavities, as the pleura and peritoneum.

The treatment of hydrops articuli, must be regulated by the knowledge of these facts:—If there be pain accompanying the disease, thus pointing out that it is the arterial system which is at fault, local bleeding, cold applications, and rest should be enjoined, before any stimulating applications are used; but if, on the contrary, the disease established itself insidiously, the patient suffering no inconvenience beyond stiffness of the joint, then blisters, tartar emetic ointment, and such medicines and means as stimulate the absorbents, should immediately be had recourse to. But although, as has been mentioned, the synovial capsules, both in structure and diseases, in many respects resemble the serous membranes, yet it should be observed, that inflammation of the synovial membranes produces a change in them, seldom if ever found in the pleura or peritoneum, namely, that of converting them into a thickened pulpy mass, which in some measure fills up the interior of the synovial sac. I shall, however, refer my readers to Sir Benjamin Brodie's Treatise on Diseases of the Joints, for a more detailed account of this morbid change. Specific inflammation, as rheumatism, frequently affects the synovial system.

When synovial membranes are wounded they are capable of reuniting. Even new synovial membranes are sometimes formed, both in cases of unreduced dislocations and non-united fractures; in the first, they seem to be produced by the remnants of the former membrane becoming united with the surrounding cellular tissue; and in the second, by the periosteum; in both cases, a viscid fluid, more or less like synovia, is secreted by them.

In chronic inflammation, the pulpy prolongations, as described by Sir B. Brodie, sometimes form such adhesions with each other as in a great measure to destroy the motion of the joint, and to produce an amphiarthrodial articulation.

Loose cartilaginous bodies sometimes form in the synovial cavities, more particularly in the knee-joint; they are generally loose within the sac, although occasionally they are fixed. No one has been able to give a satisfactory account of their formation, but it seems probable that they are originally attached to the synovial membrane by peduncles, which are accidently torn through; they then fall into the cavity of the sac, and are capable of being moved into different positions. When in this state they may be removed.

Suppuration of the synovial membranes, is very rare; and when it does occur, it is usually concomitant with ulceration of the other structures of the joint, as the ligaments and surrounding fasciæ, so that the pus becomes superficially seated. Ulceration of the synovial membrane, sometimes takes place very rapidly; and some cases are mentioned by Sir Benjamin Brodie, in which the patient died a fortnight after the injury to the joint, and where the ulceration of the synovial membrane, was not larger than a shilling. The thickening of the synovial membrane described by Sir Benjamin Brodie, seems to be caused by the organization of the adhesive matter thrown out by the membrane, subsequently to repeated attacks of inflammation. Sir Benjamin, however, seems to consider it somewhat approaching to malignancy.

LECTURE VI.

PHYSIOLOGY OF LIGAMENT.

In order to complete the description of the structures which enter into the composition of a joint, we have now to speak of ligaments, which are strong fibrous bands, passing from one bone to another, and serving to give stability to the connexion of those parts which we have already established, as essential to the formation of an articulation. Ligaments effect this purpose, either by the direct interposition of a cartilage attaching the two bones to each other, or through the means of a synovial membrane uniting the articular cartilages, which respectively cover the extremity of each bone.

Although the generic term ligament is generally used in the above acceptation, namely, that of a membranous band, passing from one bone to another, or connecting different parts of the same bone; yet the term ligamentous tissue is applied also to other structures, which belong to the same system, though they differ in their use, serving the purpose sometimes of forming bands to tie down tendons, as they pass towards their insertions; at others, connecting muscle to bone, under the name of tendon, and again developing important organs, as the kidney, &c. We shall confine ourselves at present to the first class, or ligaments connecting bones, as the others will be better understood when speaking of those structures with which they are invariably connected.

The ligamentous tissue connecting bones, is composed of firm inelastic fasciculi, of a silvery white colour, arranged in parallel lines, and strengthened by cross fibres, the whole being enveloped by a cellular tissue. Their texture is, generally, loose and fibrous on their external surface, and acquiring a greater degree of density towards the interior. They vary in thickness, shape, consistence, and adaptation, according to the function and form of the articulation which they strengthen, and the degree of motion which they serve to restrain. They differ also in number, some joints being provided only with a single ligament, while others possess several. The direction of their fibres also varies in the different articulations, but they are always so disposed as to offer resistance in a line continuous with that in which the fibres themselves pursue;

or in other words, the extent and variety of motion of which a joint is capable, may be discovered by observing the inclination adopted by the fasciculi of its different ligaments, as they pass from one bone to the other. The ligaments are inseparably united to the periosteum of the bones which they attach, and may indeed be considered as a prolongation of that membrane from one bone to the other. They are both of the same tissue, but taking the name of periosteum where covering bone; but when leaving the bone, it either becomes lined by synovial membrane, or is in contact with articular cartilage,—under which circumstance, the term ligament is applied to it.

The ligamentous tissue is but slightly vascular, although more so than cartilage. On examination, however, numerous blood-vessels are found entering between its fibres; but these are destined rather for the supply of synovial membrane and the extremities of bones, than for the organization of ligaments themselves. Nerves and absorbents are said to have been traced into ligaments, and the changes which they undergo afford evidence of their existence, although these structures, in a healthy state, possess a very small share of irritability and sensibility. The ligaments contain, in their natural state, a great portion of water, and when dried, become hard, transparent and brittle: they lose their fibrous texture, and assume a red yellowish colour. They may be reduced to charcoal by fire, and to gelatine by maceration. They are found to contain a considerable quantity of albumen.

In embryo and in infancy, the ligaments are found very soft, and more vascular than in after periods of life; and in old age they become yellow, less brilliant in appearance, are less flexible, and dry. Notwithstanding this tendency of the ligamentous tissue to become dry in old age, it is but little liable to ossify, excepting in tendons which are much subjected to pressure.

Accidental production of ligament frequently occurs in the human body, as may be seen in the formation of new articulations, as well as in the cicatrices of the skin, &c. in which this tissue is produced.

Practical Remarks.

The ligamentous tissue is liable to inflammation, which sometimes terminates in re-solution; but at other times it becomes hardened, thickened, and even ossific matter will sometimes be deposited. Long continued inflammatory action has a tendency to produce a softened and less tenacious state of the ligamentous tissue, so as to render it incapable of sustaining the common motions of a joint. Fungoid disease generally commences from this tissue, as may be frequently observed from the dura mater, and from the fasciæ covering the long muscles, or from the periosteum. When ligaments are torn through, they are capable of re-uniting, as may be seen in cases of rupture of the tendo Achillis; after which accident, if the ends be kept immoveable and in contact, an agglutination takes place, and an organic union results, which although at first is more extensible than the tendon, it acquires in time the tenacity of the original structure.

Articular Ligaments.

I shall now particularly treat of that class of the ligamentous tissue, which serves in particular to attach the bones to each other, in the formation of joints. Articular ligaments maintain the bones which they connect in their relative position, restrain and limit their motion one upon the other; they are also sometimes for the purpose of filling up vacancies in bones, and affording an expanded surface for the attachment of muscles. These divisions may each be considered as assisting more or less in the functions of joints.

In the arrangement of articular ligaments, we shall divide them into *seven classes*, as it is clearly seen they somewhat differ from each other in their form, situation, structure, and use.

In the *first class*, may be considered the capsular ligaments, which are found belonging to some of the moveable joints: they have their edges attached around the articular margins of the two bones which they serve to connect; they thus enclose the articular cartilages, and are lined internally by the synovial capsule. These ligaments are strong and fibrous, in proportion to the degree of motion enjoyed by the joint which they enclose, and obtain further stability in particular parts, either by their additional thickness, or by the passage of muscle or tendon over their surface, where greater strength is required. There are only two perfect capsular ligaments in the body, one belonging to the hip, and the other to the shoulder-joint.

The *second class* comprehends those which run in bands over joints, and are named according to their situation, with respect to the articulation, anterior, posterior, or lateral. Several of these generally belong to one joint, and are loosely connected with each other by irregular fibres, so as to form an imperfect capsule: we have specimens of such in the knee and ancle-joints. Some of the ligaments of this class, in passing to their insertion, wind around a bone in the form of a ring, and in this manner unite a neighbouring bone; this may be seen in the coronary ligament of the radius, and the ligament proper to the atlas.

The *third class* is found in those immoveable joints, where the union between the bones is established by means of one intervening cartilage, and consists of short strong fibres, passing in an irregular manner from one bone to another, so arranged, indeed, as to be best adapted to furnish strength and prevent motion. Instances of this class are found in the sacro-iliac and pubic symphises.

The *fourth class* are those which exist within joints, or, more properly speaking, between the articular surfaces of the bones, and consequently nearer to the centre of motion. They are surrounded by a reflection of the synovial capsule, to which, however, they are always external. Such are the crucial ligaments of the knee, and the ligamentum teres of the hip-joint. They are properly called the inter-articular ligaments.

The *fifth class* comprehends those ligaments which are not only for the purpose of connecting bones, but assist in forming a surface for the reception of the articular face of a bone, as in the ligament extending from the os calcis to the os naviculare. Its particular use is to prevent violent concussion, which must inevitably have occurred, had the astragalus been received wholly upon the unyielding structure of the os calcis.

The *sixth class* includes those ligaments whose points of attachment become widely separated from each other, during the different motions of the bones which they connect, and which require therefore elasticity, as well as flexibility, to enable them to recover their form when in the quiescent state. By this property of elasticity, they diminish the necessity for muscular power. The bony arches of the vertebra are connected by this structure, which becomes elongated when the spine is flexed, and by its elastic power assists in bringing the separated spinous processes again together, thereby producing an erect posture of the body.

The *seventh class* consists of those ligamentous fibres, which either serve to fill up an opening in one bone, or to connect bones to each other, without entering into the composition of a joint: they answer the double purpose of giving strength and affording a surface for the attachment of muscles. The ligamenta obturatoria, and interossea, constitute examples of this class.

All these classes, more or less, resemble each other, in being much longer and broader than they are thick.

Practical Remarks.

Articular ligaments are, from their situation and use, very liable to be distended beyond thir natural limits, which extension is calculated to excite inflammation, constituting the affection commonly denominated sprain; and which, under ordinary circumstances, it is very difficult to subdue: rest is perhaps to be considered as the best means of cure; and this can only be ensured by applying splints upon the affected joint, so as entirely to prevent its motion. A specific inflammation also sometimes attacks these ligaments, as is seen in gouty and rheumatic diatheses. Inflammation gives rise to two different effects in the ligaments, sometimes in their becoming so altered in their structure and texture as to lose the power of offering sufficient resistance, as to restrain the motions of a joint; and at others, it is found to undergo accidental ossification, which is most frequently observed in scrofulous patients.

LECTURE VII.

FIBRO-CARTILAGINOUS TISSUE.

THE fibro-cartilaginous tissue partakes equally of the physical properties, structure, and texture of the fibrous and cartilaginous systems, possessing the flexibility of the one and the elasticity of the other, thus rendering it impossible to class it with either of those systems; but it should rather be considered as a link between the two.

Fibro-cartilage is composed of true cartilage, placed in the intervals of a densely interwoven fibrous tissue: the former gives to fibrous-cartilage, whiteness, smoothness, and elasticity; while the latter imparts to it the fibrous and metallic lustre of ligament, as well as flexibility.

This tissue is found in three different situations in the human body; *first,* in the formation of important organs, as in the alæ of the nose, the external ear, the eye-lids, and the trachæa: *secondly,* entering into the composition of joints; and *thirdly,* lining grooves and forming sheaths, for the passage of tendons to their insertions. These three classes, although very similar in appearance, yet differ in their form, chemical composition, and physical properties, possessing more or less elasticity and flexibility, according to the function the organs they enter into are destined to perform.

In the *first class,* where they form part of the ears, nose, &c., they are found expanded, so as to be considered by Bichat as worthy of being termed "fibro-cartilaginous membranes;" but they are truly belonging to this system, being composed both of cartilage and ligament; but differently disposed, and evidently in different proportions to this tissue, in other parts of the body; for in these situations they are covered by a membrane termed perichondrium, which may be considered as forming the fibrous portion of their structure, and enclosing the cartilaginous tissue; and further, by boiling they do not yield so much gelatine as other fibro-cartilages.

The *second class,* or articular fibro-cartilages, are found in two kinds of joints; in the one they are found free, not being connected with articular cartilages, but separated from the bones of the articulation to which they belong by the synovial membrane, which these fibro-cartilaginous bodies divide into two perfect sacs; these are found in such situations, where they are much exposed to violent motion. The other kind are fixed in a solid manner to the bones themselves, as in the vertebræ; and admit of the motion of these bones upon each other, from the physical properties they possess of flexibility and elasticity: they are alike, however, in being firm, resisting, dense, and intricately interwoven, so as powerfully to resist injury. This is exemplified by the strength with which the vertebræ are attached, and by the difficulty of breaking or otherwise destroying the inter-articular structures of the jaw and clavicle; and also by the resistance which they oppose to luxations.

The *third class*, which have been described for the purpose of facilitating the motion of tendon, seem to proceed from the periosteum, which probably furnishes its fibrous structure, while the bone itself supplies the interstices of this ligamentous tissue with cartilage, and thus forms the fibro-cartilages which enter into the composition of tendinous sheaths.

The following observations will exemplify the use of this tissue in its three different situations: in the ear, nose, and trachæa, &c., it affords a structure capable of assuming that determined form best adapted to the functions of the organ to which it belongs, while at the same time this form is capable of change from the influence of muscles, while its elasticity allows it spontaneously to re-assume its original character, when no longer under the influence of muscular action. Its elasticity is further illustrated by the readiness with which the symmetry of these parts is restored, after contortion produced by the formation of abscess, tumour, or any cause subjecting them to pressure.

The second class, or the articular fibro-cartilages, seem destined, from their elasticity, to prevent concussion of the bones; from their flexibility, to admit of the motions of the joint; and from the density of their texture, to afford strength and security. We find them separating the synovial membrane into two distinct sacs, in such joints where they are for the purpose of increasing the extent of motion, and in a manifest degree adding to the stability of the articulation. The temporo-maxillary, the sterno-clavicular, the inferior radio-ulnar articulations, offer the best examples of these cartilages; but there may also be added the semilunar cartilages of the knee-joint, which may be considered as an imperfect specimen, as they are two in number, and instead of completely separating the bones, and dividing the joint into two synovial cavities, merely project into the articulation, and are covered on both surfaces by the same synovial membrane. If, however, we consider these two semilunar cartilages as forming one complete cartilage of a circular form, we shall then find that they bear a strong analogy to a variety which occasionally takes place in the more perfect joints of a similar character, namely, where an opening is found to exist through the inter-articular cartilage, which forms a communication between the synovial capsule of the one side and that on the other; or, in other words, by allowing a continuity of the lining membrane, throws into *one* what would otherwise be *two* shut cavities, distinctly separated from each other.

But it is not only in the moveable joints above described that we find the existence of this second class of fibro-cartilage, since it is likewise employed for the purpose of connecting bone immediately with bone, under those circumstances where considerable motion is required, together with great strength, and a capability of resisting violent concussions, united with a tendency to resume its original form after having been either compressed or drawn out by muscular action, or any other mechanical force. All these qualities are admirably combined in the fibro-cartilage connecting the bodies of the vertebræ, generally called the intervertebral substance; and their utility is beautifully illustrated by the easy flexibility which the spinal column enjoys, supporting at the same time the whole weight of the trunk, and bearing the shock of every concussion which the body may receive. We may here observe, that this last-mentioned structure bears a great resemblance to that class of *true* cartilage which we described as connecting bone to bone, in the formation of the pelvis, &c.; and, indeed, this gradual assimilation of one structure to another, will be found to pervade the whole body, and renders classification proportionably difficult. We would, however, distinguish the two kinds by observing, that the one allows a manifest degree of motion and compression, while the other suffers only a slight and insensible yielding to take place; that in the former, fibrous tissue, and in the latter, the true cartilaginous structure is found to predominate.

Concerning the use of the third class of fibro-cartilage, nothing further need be said, except, that by lining grooves and depressions, they form smooth and somewhat yielding structure for the tendons to play over, and are in most places prolonged into sheaths, which bind down the tendons, and prevent them from starting from the bone during the action of the muscles. These sheaths are lined by synovial membrane, which connects them to the tendons as they pass through.

Organization of Fibro-Cartilage.

Besides the fibrous and cartilaginous tissues, we find celular membrane entering into the composition of fibro-cartilage: but this, however, is so little in quantity, and so intimately connected with the two former tissues, that it is very difficult to separate them; but by maceration the three structures are rendered perceptible.

The fibro-cartilaginous tissue possesses but little vascularity in the healthy state; although under inflammation, in which it participates in common with contiguous surfaces, we find it injected with red blood. Neither nerves or absorbents have as yet been traced to this system.

Practical Remarks.

This tissue seems to possess but few of the vital properties, and in a healthy state it has neither sensibility or animal contractility: the former, however, developes itself under inflammation. Even those phenomena of life which it does possess, are remarkable for the slowness of their developement: the extreme difficulty of re-union after division, and the rareness of idiopathic disease affecting fibro-cartilage, fully proves this position. In thoracic and abdominal aneurism, it is not uncommon to find the bodies of the vertebræ partially or wholly destroyed, without a corresponding change of the intervertebral substance. In fact, it may be said, that there is no structure in the human body so little liable to disease as this tissue. In some situations in the human body, fibro-cartilage has a tendency to become bone at certain periods of life, as may be observed in the stylo and thyro-hyoideal ligaments; even the sesamoid bones, strictly speaking, are of this nature. This phenomenon has induced some physiologists to divide fibro-cartilages into two classes: namely, permanent and temporary.

Accidental formations of fibro-cartilages sometimes occur after fractures, instead of the production of that temporary cartilage which is necessarily converted into bone; thus producing a supernumerary amphiarthrodial articulation.

In old age this tissue gradually loses its elasticity, and hardens so as to be rendered less yielding and flexible, and consequently more prone to suffer from external injury.

Ossification never occurs in the fibro-cartilages of the ear, eye-lids, or nose.

LECTURE VIII.

GENERAL ANATOMY OF ARTICULATIONS.

By an articulation, or joint, is meant the union of two or more bones, by some intervening medium of connexion, differing in structure from the bones themselves ; and when they are represented as thus retaining the different portions of the osseous system in their relative situations, the whole is said to form a natural skeleton.

The classification of bones, according to their size and shape, and their anatomical description, has already made us acquainted with the precise points at which they become connected with each other. It is a general rule that long bones meet at their extremities, flat bones at their edges, and the short bones at different points of their surfaces. The shape and configuration of the different processes of bones, which thus become contiguous, is a most important consideration in the study of joints, as on that depends, in a great measure, both the function of the articulation, and its liability to injury. Moreover, we shall always find a certain degree of correspondence between the articulatory surface of the bones and the other structures concerned in their union.

The uses of joints are either to allow of a positive and evident motion between the bones which they connect, through the influence of muscles, or merely to permit such a relaxation or yielding, as may lessen the injurious effects of concussion, or accidental pressure.

The parts which enter into the composition of articulations, consist of all those structures hitherto described in these lectures: namely, *bone, cartilage, fibro-cartilage, synovial membrane,* and *ligaments.* The only one of these structures, however, which is actually essential to every joint, is bone; for the bones may be connected by a fewer or greater number of the other tissues, according to the office which the joint has to perform.

Generally speaking, a joint is the more perfect, and enjoys a greater variety and extent of motion, in proportion to the number of these structures included in its formation. Thus, in the most perfect and moveable articulations, we recognize bone, for the purpose of affording firmness; cartilage, to give elasticity; synovial membrane, to obviate friction; and ligaments, to bind the whole together, and prevent dislocation. On the other hand, in those joints where no positive motion is allowed, we find that the bones are merely connected by an intervening cartilage, either with, or without ligament.

These observations will naturally suggest the division of the articulatory system into two kinds,—the *moveable* and the *immoveable.* The former is best exemplified in the extremities; while the latter is employed in the junction of such flat bones as enter into the composition of osseous cavities, as the head and the pelvis. As, however, the human body furnishes instances of every possible gradation, between the highly moveable and that which is possessed of scarcely a perceptible yielding, we generally add a third kind of joint, as a connecting link between the two, and partaking of the nature of both: we shall therefore distinguish three species of articulation:—the *diarthrosis,* or moveable, the *synarthrosis,* or immoveable, and the *amphiarthrosis,* which is of an intermediate or mixed character.

The first of these generally includes in its formation all the tissues which have been enumerated as belonging to joints; the second is furnished with only a limited number; while, in the third, the union of the bones is generally accomplished by means of fibro-cartilage. This correspondence between the different species, and their respective structures, will not be found to hold good in every instance, as it is liable to exceptions, which will be noticed when speaking of the joints individually. We shall now proceed to particularize the three divisions.

Diarthrosis.

(διαρθροω, to articulate.)

This is the most moveable articulation of the whole, and connects all the bones of the extremities to each other, as well as the extremities themselves, to the trunk. In a diarthrodial joint, the articulatory surface of each bone is covered by cartilage; it is lined by synovial membrane, and the whole strengthened, more or less, by ligament. It is in some joints of this class that the inter-articular cartilages occur. Diarthrosis is subdivided into four species, characterized by the shape of the articulatory surfaces of the bones, and the consequent motion which the joint allows. These are *enarthrosis, arthrodia, ginglimus,* and *trochoides.*

Enarthrosis (εν, in, αρθρον, a joint), is where the rounded head of the one bone is received into a corresponding cavity in the other, rendering it capable not only of motion in every possible direction, but of rotation on its own axis. This is, therefore, the most moveable of all articulations. Numerous specimens are to be met with, differing from each other according as the cavity is deep or shallow: the former is well illustrated by the hip, the latter by the shoulder-joint. The degree of motion is regulated, not so much by the depth of the socket as by the adaptation of the ligaments, and the surrounding muscles.

Arthrodia (αρθρον, a joint), is formed by the approximation of two plane, or nearly plane articulatory surfaces, covered by cartilage and synovial membrane: this constitutes the most immoveable joint belonging to this class, as the bones are only allowed to glide slightly one upon the other. An assemblage of contiguous small bones are generally united in this manner, and produce a combined, rather than an individual motion: take for example the carpus and tarsus. It is sometimes difficult to draw a line of distinction between the true arthrodial and the most shallow forms of the enarthrodial joints.

Ginglimus (Γιγγλυμος, a hinge).—In this species we observe a convexity of one bone received into a corresponding concavity in the other. Both articulatory surfaces are lengthened laterally; and the sides of the joints are so secured by processes of bone, or strong bands of ligament, as only to allow of motion in a backward and forward direction; or, as it is generally termed, of flexion and extension. This articulation enjoys considerable extent of motion, but it is limited as to direction. Examples are met with in the elbow, knee, and ancle.

Trochoides (τροκος, a wheel, ειδος, resemblance), is when a projecting process of bone is received into an articulatory cavity, formed partly by bone and partly by ligament, where it performs a rotatory motion on its own axis; as we see the dentiform process of the second vertical vertebra rolling within the atlas; or the neck of the radius on the coronary ligament.

Thus it will be seen, that although similar structures are employed in the formation of all diarthrodial joints, yet they vary in a most remarkable degree, as regards their solidity and the extent and direction of their motion; and this difference is to be ascribed entirely to the shape of the articulatory surfaces of the bones, and the manner in which the different structures above mentioned are adjusted in their union.

The solidity of these articulations, and their power of resisting injury, is always in an inverse proportion to their mobility. Whilst speaking of the stability of articulations, we should not neglect to observe, that the muscles which surround them afford perhaps a stronger means of defence, and a more efficient power to restrain undue motion, than the ligaments themselves: in fact, a certain balance will be found to exist amongst the muscles, which pass from one bone to the other, over the different surfaces of a joint; so that when those on the one side have drawn the bone in their direction to a certain extent, the antagonizers on the opposite surface exert themselves to prevent a continuation of the same motion. It sometimes happens, however, that under some extraordinary muscular exertion, exercised in a particular direction, this counter-resistance is lost, or overcome; and thus bones may occasionally be dislocated by the action of the muscles which move them. These remarks are more particularly applicable to the ball and socket-joints.

Accidental diarthrodial articulations are sometimes produced from the non-union of fractures, or from unreduced dislocations; in the former case giving rise to a supernumerary, in the latter to a supplementary joint.

The failure of union in fractured bones arises either from a want of proper adjustment in the first instance, from improper motion, or from constitutional causes; preventing the usual process which nature sets up to produce union: the fractured extremities then become moulded upon each other; and, by the constant friction which is kept up, their respective contiguous surfaces are rendered perfectly smooth, and capable of gliding one upon the other, almost as readily as if they were covered by articular cartilage. They are further surrounded by a fibro-cartilaginous capsule, produced from the periosteum, the internal surface of which secretes a fluid resembling synovia. Wherever the irregularity of the fracture prevents the bones from coming in contact with each other, the interspace is filled up by portions of the same kind of fibro-cartilage as envelopes the exterior of the joint; but these become gradually absorbed, as the friction grinds down the inequalities of the fractured surfaces, and enables them to adapt themselves more completely to each other. Thus the articulation becomes more perfect from motion and use.

Supplementary articulations are found to succeed unreduced dislocations; instances of which most frequently occur in the hip and shoulder-joints. Under these circumstances, the head of the dislocated bone, by its pressure, produces absorption of the intervening soft parts covering the bone on which it had been thrown; and, as soon as they are in contact, an alteration takes place in both: the articular cartilage of the one becoming absorbed, and a recipient cavity produced in the other. The head of the bone also becomes flattened, and the new-formed cavity is shallow in proportion. No new articular cartilage becomes deposited in this process, but the contiguous surfaces assume an altered character, being rendered perfectly smooth and hard, as in the former instance, presenting an appearance resembling porcelain. A new and very complete capsular ligament is produced, which is lined internally by an imperfect synovial membrane. The old articular cavity, from which the head of the bone had been thrown, being now rendered useless, becomes partly obliterated, much altered in form, and filled up by a fibro-cartilaginous tissue.

Synarthrosis.

(συν together, αρθρον a joint.)

Synarthrosis, is the name given to those articulations where the bones are joined by a single intervening cartilage, inseparably united to them both, and allowing of a mere yielding, which is greater or less in proportion to the thickness of the connecting structure. It is made use of to unite different portions of bone into one apparently solid fabric; which, by this combination, is rendered less obnoxious to injury than if it had originally consisted of one entire bone. These articulations are strengthened by the periosteum, which passes from one bone to the other; and, in many instances, by ligamentous bands, producing so firm a union, that they can only be separated by the same degree of violence as would fracture the bones.

Synarthrosis is subdivided into several varieties: such as the *serrated,* and *squamous suture, harmonia, schindylesis, gomphosis,* and *synchondrosis.*

The *serrated,* or *true suture,* is where the edges of the bones are dove-tailed into one another, by means of irregular projections and corresponding indentations, which are most prominent at their external surfaces, as is seen in the junction of the parietal bones.

The *squamous,* or *false suture,* is formed by the edge of one bone overlapping that of another, while the two surfaces thus approximated are slightly grooved instead of serrated: for instance, the temporal and parietal bones.

Harmonia, constitutes the mode by which most of the bones of the face are united. Here the surfaces are only in juxta-position, but present slight irregularities, which are fitted to each other; or when two edges are brought together, there is a slight overlapping.

Schindylesis, is the insertion of a plate of one bone into the groove of another. The junction of the sphenoid bone with the vomer, exemplifies this species of articulation.

Gomphosis, is where a conical portion of bone is implanted into a cavity, corresponding in shape: the only instance of this is afforded by the reception of the teeth into their alveolar sockets. We may here observe, that in all these species of synarthrodial articulations, the intervening cartilage is extremely thin, being hardly distinguishable from membrane:

they are likewise all destitute of ligament. They constitute the most solid and immoveable form of union.

Synchondrosis, is the term applied to those joints where the union is effected by a strong and thick portion of cartilage, which presents a larger surface externally than internally, and allows the greatest degree of yielding of which this class is capable. Examples of this are found in the sacro-iliac and pubic synchondrosis. The different portions of the same bone in the young subject, are also connected in this manner. The term symphisis, is frequently used to denote the union of the pelvic bones.

Although we have described the synarthroidal joints as destitute of positive motion, yet the degree of yielding and contortion which they allow, differs materially at different periods of life, and under different healthy and diseased alterations which take place in the body. We may here remark, that by the term yielding, we signify that kind of motion which is produced by accidental mechanical pressure, and totally independent of the action of the voluntary muscles; for we shall find no muscles so situated as to produce a change of situation between any two bones connected by this class of articulation.

The synarthrodial joints have a greater and more constant tendency than any of the others, to become firmer and less pliant as age advances. Thus, in the newly-born infant, the bones of the head are widely separated from each other, being merely connected by membrane: they gradually approximate for the developement of suture; and, at later periods of life, consolidate into one continuous mass, to the actual obliteration of any apparent seam. This last process always commences from the internal surface, which may be proved by the examination of skulls at advanced periods of life, at which the sutures may still be traced on the exterior, although all vestige of them is lost internally.

On the other hand, under disease, the sutures may become unnaturally separated, as may be seen in hydrocephalus, and the synchondroses of the pelvis, which are sometimes found to yield and become elongated, under difficult, and protracted cases of parturition.

Amphiarthrosis.

(αμφι, both, αρθρωσις, an articulation.)

The *amphiarthrosis*, or *mixed articulation*, resembles synarthrosis in the manner by which the bones are united, and diarthrosis from the greater extent of motion which is allowed. Fibro-cartilage is the structure employed to effect the union, and the joint thus formed, is partly under the influence of muscular action. The bodies of the vertebræ are connected to each other by this class of articulation, and the motion thus allowed has been already mentioned, when speaking of fibro-cartilage. The connecting structure gradually loses its elasticity as age advances, but the joint is but little liable to become obliterated by ossific deposition. After some unconsolidated fractures, a species of amphiarthrodial joint is produced, from the fractured extremities of a bone being re-united by an intermediate substance, of a flexible and tenacious texture, which allows them to move one upon the other: such a texture is frequently produced after fractures of the patella, neck of the femur, and olecranon. Indeed, wherever mechanical or constitutional circumstances interfere with the re-union of bone, either a supernumerary amphiarthrodial, or diarthrodial articulation is the consequence.

Practical Remarks

I can scarcely be expected, while treating of anatomy, to enter fully into the detail of the diseases to which joints are liable, having already mentioned the peculiar affections of each structure which enter into their composition: but I shall only urge the necessity of bearing in mind the complicated structure of articulations, the peculiar functions they have to perform, and their consequent liability to morbid affections. I may, however, perhaps with advantage recapitulate, that as bone, cartilage, synovial membrane, and ligaments, are all necessary to the formation of a joint, and that as each is susceptible from numerous causes to inflammation and its consequences, that the symptoms produced are as various as the structures, and that a thorough knowledge of them can only be gained by a strict attention to the altered function of the affected articulation. I shall, however, make some few remarks with respect to the wounds of joints; and what is first to be considered as most important, is the manner in which the wound was inflicted, and the depth to which it has penetrated; for we find the danger great in proportion to the violence and contusion sustained, and to the depth and extent of the wound, with injury to important parts. When a joint is wounded, the term implies an opening into the synovial cavity, accompanied frequently with injury to the other structures of the joint, as ligaments, vessels, and even sometimes cartilages and bone. When the synovial cavity is opened, it is generally indicated by a flow of the synovia from the wound; but even this, it is to be remembered, does not always point out the actual nature of the case, as the synovia may escape from a bursa mucosa in the vicinity of the injured joint, and not from the articulation itself: hence the necessity of a just anatomical knowledge, by which the surgeon should be enabled to form his judgment, without the necessity of the introduction of a probe, which is so liable to excite inflammation, and to cause therefore more mischief than the wound itself. In these cases the treatment is the same, whether injury to the synovial capsule be proved, or only suspected; namely, that the wound be immediately closed by adhesive plaister, that the joint be placed and maintained in a perfect state of rest, that evaporating lotions be applied, and that the antiphlogistic regimen be strictly enforced; and under such treatment, incised wounds of joints frequently heal favourably, without any dangerous symptoms; as is seen after the operation for removing loose cartilage from joints: but this, however, is not invariably the case; for in some constitutions of a highly inflammatory tendency, the injury is followed by violent inflammation of the synovial cavity, leading to suppuration within the joint, and frequently terminating by the destruction of the cartilages, and even disease of the osseous structure itself. These effects are generally accompanied by excessive constitutional irritation, which often rapidly carries off the patient; or, should his strength of constitution enable him to overcome the consequences of the injury, an anchylosed joint is generally the result. As may naturally be expected, the danger attendant upon wounded joints depends upon the extent of injury as above mentioned, together with the state of constitution and previous habits of the patient. It is by attention to these circumstances that the surgeon is enabled to judge whether or not the patient has strength enough to sustain the attempt at reparation, or whether it be advisable to remove the limb; the object of the surgeon being, first, to place the life of his patient in security; secondly, to serve the limb, if possible; and thirdly, to produce anchylosis, with such a position of limb as may render it best fitted to perform its natural functions. After all our attempts, it sometimes happens that anchylosis is not complete so that some degree of motion is yet allowed in the joint. If the articulation, under these circumstances, be one destined to receive the weight of the body, as in those of the lower extremities, and more especially the knee, it becomes constantly subjected to concussion, followed by frequent attacks of inflammation, which, by exhausting the strength and undermining the constitution of the patient, may yet render amputation necessary. I have several times been obliged to amputate a limb under these circumstances.

Loose cartilaginous bodies are not unfrequently found within the cavities of joints. They are most frequently found in the knee-joint; but occasionally occur in the carpal, and temporo-maxillary articulations. There are a variety of opinions with respect to the formation of these bodies; but they are probably the result of inflammation of the synovial membrane, producing a deposit which naturally assumes the character of the neighbouring cartilage, but differs from it in having a tendency to become ossified. As long as these bodies remain attached to the synovial membrane, they produce little or no inconvenience; but as soon as from any cause they become separated, they then interfere with the functions of the joint, and render their removal necessary. The danger attendant upon the opening of a joint should lead the surgeon to consider duly the state and constitution of his patient, before he attempts the operation, which should be performed as follows. The loose body being directed by the operator to the situation most favourable for its removal, namely, on the inner side of the patella, should be retained there by the thumb and fore-finger of the operator, while an assistant draws the skin tightly over the patella. An incision should then be made directly on the body, and of a size sufficient to admit of its extraction. The skin is then allowed to recover its former situation, and thus the wound into the capsule becomes effectually closed. A splint should then be placed behind the knee, so as to retain it in an extended position, and the usual precautions for preventing inflammation, adopted, and continued until the wound is entirely healed.

LECTURE IX.

DESCRIPTIVE ANATOMY OF ARTICULATIONS.

Articulations of the Head and Spine.

The sutural connexions of the bones of the head and face having already been spoken of, the only articulation proper to the head which remains to be described, is the *temporo-maxillary.*

Articulation of the Lower Jaw.

Class *Diarthrosis.*—Subdivision *Arthrodia.*

The *inferior maxillary bone* forms a double articulation with the temporal bones, the condyloid processes of the former being received into the fossæ condyloideæ of the latter bone. These cavities are bounded, behind by the fissura glasseri, which separates them from the fossæ parotideæ; and before, by the root of the zygomatic arch, which presents a transverse ridge, marking the extent of their articulatory surfaces. The glenoid cavity, and that part of the root of the zygoma included in the articulation, are covered by a thin cartilage. The *condyles* of the lower jaw have their long axis from side to side, and are also covered by articular cartilage, presenting a larger surface before than behind: they do not precisely correspond in shape with the glenoid cavity, in consequence of the interposition of an *inter-articular fibro-cartilaginous* tissue, which forms a thin layer, transversely oval, presenting a broad superior and inferior surface, which, under the different motions of the jaw, adapt themselves to the surfaces of the two bones. It is somewhat in the form of a wedge, being thicker behind than before; and into its posterior edge some small arteries may be traced: its centre is always very thin, and is sometimes perforated, forming an opening between the two synovial cavities. Its circumference is attached to the lateral ligaments.

Its *use* is to facilitate and extend the motions of the lower jaw, and partly to give insertion to the pterygoideus externus muscle. This articulation is strengthened by an external and internal lateral, and the stylo-maxillary ligaments.

The *external lateral ligament* is composed of short, thin, parallel fibres, which are united by a dense cellular membrane.

It is attached above, by a broad origin, to the articular tubercle and other edge of the glenoid cavity, and to the anterior edge of the meatus auditorious externus. It extends obliquely backwards, and terminates on the outer side of the neck of the lower jaw: externally, this ligament gives support to the parotid gland; and internally, it is in contact with the inter-articular cartilage, and is covered by synovial membrane.

The *internal lateral ligament* is composed of a number of narrow slender fibres, of considerable length, which arise from the inner edge of the glenoid cavity; it passes obliquely downwards and forwards, but immediately divides into two fasciculi: the outer fasciculus, or that one nearest to the bone, is much the shorter, and is attached to the inner side of the neck of the jaw; while the internal, or longer fasciculus, enlarges as it descends, and is inserted into the upper and fore part of the posterior maxillary foramen: its point of insertion is a small spinous process which partly covers that foramen, and, projecting somewhat from the jaw; leaves a space for the passage of the dental artery and nerve, which are thus protected from the action of the pterygoideus internus muscle. The precise situation of this ligament is, first between the pterygoidei muscles, and then between the pterygoideus internus, and the ascending plate of the lower jaw.

The *stylo-maxillary*, or *suspensory ligament*. This ligament arises from the styloid process of the temporal bone, passes downwards and a little forwards, and is inserted by rather an extended surface into the angle of the lower jaw, between the fibrous of the masseter and pterygodeus internus muscles. This ligament seems to be of more importance in affording the surface for the attachment of the stylo-glossus muscle, than in connecting the temporal bone, with the lower jaw.

The *synovial membrane* gives an internal covering to the two lateral ligaments which I have described, and is also reflected over the cartilaginous surface of the glenoid cavity in the temporal bone, and the condyloid process of the lower jaw. But by the intervention of the inter-articular cartilage, this membrane is divided into two distinct synovial cavities: the upper compartment, which is the larger, is situated between the glenoid cavity and the superior surface of the inter-articular cartilage; and the lower one is placed between the inferior surface of the cartilage and the condyloid process of the jaw. The synovial membrane is strengthened laterally by the lateral ligaments of this joint; anteriorly, by the tendon of the pterygoideus externus; and posteriorly, by the condensed cellular membrane covering the parotid gland: it is looser posteriorly than in the anterior part.

Motions of the Lower Jaw.

Man being an omnivorous animal, we find that the lower jaw is moveable in various directions, as the different substances on which he feeds require different actions of that part for their complete mastication. It admits of motion downwards, upwards, forwards and backwards, and has also lateral motion.

When the lower jaw is depressed and the mouth opened, we find the condyloid process changing its situation in the glenoid cavity; so that its upper surface is turned forwards upon the root of the zygomatic arch, the angles of the jaw are thrown backwards, and the coronoid processes are thus depressed. The inter-articular cartilage, in consequence of the limited size of the inferior synovial cavity, is always in of contact with the condyloid process of the lower jaw. The ligaments also undergo an alteration, with respect to the states of relaxation and extension. The external and internal ligaments are rendered tense in proportion to the depression of the jaw; and the upper synovial cavity is drawn forwards, which movement its laxity allows; but the membrane between the inferior surface of the cartilage and the lower jaw, remains stationary, as the cartilage and condyloid process move together, in consequence of the firm attachment of the lower part of the ligament.

The stylo-maxillary ligament is relaxed.

When the jaw is elevated, the condyloid process recedes into the glenoid cavity; and having arrived there, the superior surface turns upon its own axis until the teeth are brought into apposition, when the motion is completed. The position of the ligaments is changed precisely to the reverse of their state in the former motion: viz., the lateral ligaments are relaxed, the stylo-maxillary is extended, and the superior synovial membrane becomes again relaxed.

When the jaw is drawn forwards, or protended, there is no motion of the hinge, but the whole jaw moves horizontally in advance, so that the condyle and the angle pass simultaneously forwards. In this motion all the ligaments are put upon the stretch, excepting the inferior part of the synovial membrane, which is kept in its relative position, with respect to the inter-articular cartilage and condyloid process, by the attachment of the external pterygoid muscle, which is inserted into them both, and keeps them in situ.

The motion of the jaw backwards, or when retracted, seems to be nothing more than replacing it, after it has been drawn forwards by the pterygoid muscles; for in the natural position we find no muscles capable of giving it motion in that direction.

The lateral motion is produced by the condyle of the jaw being carried outwards on the one side, and inwards on the other. This motion is of limited extent, as it is soon opposed by the vaginal process of the temporal, and the spinous process of the sphenoid bone; but some advance may take place of the jaw on one side; in which case, the condyloid process, on that side, passes forwards on the root of the zygomatic process; while, on the other, it acts in the glenoid cavity as the centre of motion; and it is by inordinate degrees of motion in this direction, that dislocation on one side sometimes occurs.

Practical Remarks.

There is but one direction in which the lower jaw can be dislocated: in this case, the condyloid process is thrown forwards and downwards under the zygomatic arch; this displacement is produced by strong muscular action, while the jaw is in a state of complete depression. The mouth is mechanically kept open by the advance of the condyloid process under the zygomatic arch, so that the ligaments are much in the same state as in the natural depression of the jaw; unless, from the great degree of violence which has been exercised in producing the injury, the extension be so great as to cause the laceration of the external lateral ligament and superior synovial membrane.

I have never obtained an opportunity of examining the parts by dissection after this accident, except by producing the dislocation *post mortem*, when the muscles are found in the following state. The temporal muscle is subjected to a great degree of extension; and I should think in the living subject, in whom there would be a strong counteracting muscular power, that its posterior fibres would be frequently ruptured from the advance of the coronoid process, into which it is inserted.

The masseter muscle, in consequence of the decussation of its fibres, is, with respect to its anterior and posterior edges, placed under exactly different circumstances; the anterior being relaxed, and the posterior forcibly and painfully extended. The pterygoideus internus is in a complete state of relaxation, the two bony attachments of the muscle being brought closer together. The external pterygoid muscle is also relaxed, in consequence of the condyloid process of the lower jaw being thrown nearer to the sphenoid bone, from which this muscle arises.

A perfect knowledge of the situation of muscles under dislocation is quite essential to every medical practitioner, in order that he may be enabled to point out the best mode of reduction, by relaxing those muscles which are put upon the stretch. Nor are frequent opportunities of observing these accidents necessary for the acquisition of such knowledge, because accurate observation of the ordinary functions of the muscles will enable the practitioner to perceive their unnatural state under dislocation. In proceeding to reduction it should be borne in mind, that the action of muscles will present the only obstacle in a case of recent displacement. Thus, in reducing the dislocation of the jaw, the object is by force to depress the condyloid process below the zygoma, and by pressing it backwards, cause the posterior fibres of the masseter and temporal muscles to draw it into the glenoid cavity.

In the subsequent treatment of this case, where we have reason to suspect the laceration of muscular fibre, the jaw should be kept closed as much as possible, to afford the best chance for their perfect re-union.

Displacement of the lower jaw, as has been already observed, sometimes happens only on one side; but the mode of reduction, and the ulterior treatment, do not differ from the plan laid down in cases where both sides are dislocated. The difference between the two accidents is so strikingly obvious to the most cursory observer, as to render it quite unnecessary for me to make any remarks on the diagnostic symptoms.

Articulations of the Vertebral Column.

From the number of bones which enter into the formation of the spine, its ligaments must necessarily be numerous and complicated. They may however, to facilitate their description, be divided into two distinct sets: those which are common to all the vertebræ, and those which only appertain to particular bones of the column. I shall first describe the ligaments *common* to the articulations of the spine.

Articulations common to the Vertebræ.

All the vertebræ are connected by ligaments at their *bodies,* at their *articular, transverse, spinous processes,* and also at their *bony arches.* The articulation of the bodies of the vertebræ is effected by the common anterior and common posterior vertebral ligaments, and by an inter-vertebral substance.

Articulation of the Bones of the Vertebræ.

Class *Amphiarthrosis.*

The *common anterior vertebral ligament* originates at the lower edge of the anterior portion of the circular ligament, on the upper part of the second cervical vertebra, and extends to the sacrum, varying in breadth and thickness in its descent. It is thin and narrow on the cervical vertebræ, thicker and wider on the dorsal, and again becomes attenuated, but is at its greatest breadth in the lumbar region. It is composed of numerous distinct longitudinal fibres, which are separated for the transmission of blood-vessels. This ligament expands itself more widely over the inter-vertebral substance than in its passage over the bodies of the vertebræ. Its anterior surface through the cervical region is covered by the pharynx and œsophagus; on the dorsal, by the œsophagus, aorta, thoracic duct, and vena azygos; and on the lumbar, by the aorta, vena cava, and the receptaculum chyli. Its posterior surface is in contact with the vertebræ themselves and with the crucial ligaments, and is also laterally connected with the longus colli muscle. If the common anterior ligament be raised from the inter-vertebral substance, small *decussating* fibres may be seen passing from the lower edge of the vertebra above, to the upper edge of the vertebra below, crossing each other as they pass; from which circumstance they have been termed the *crucial ligaments*. The common anterior vertebral ligament has the shining metallic lustre of the fibrous system generally: it is composed of a superficial and deep layer of fibres; the latter being firmly connected with the vertebræ themselves, while the former are strengthened in the cervical region by the tendinous origin of the muscles of the neck, and in the loins by the crura of the diaphragm, so as to add much to its strength in the most moveable parts of the vertebral column.

Common posterior vertebral ligament.—This ligament is usually described as arising from the lower part of the second cervical vertebra; but that portion which, by some anatomists, is called the *perpendicular ligament* of the dentiform process, is in fact the commencement of the common posterior vertebral. It takes origin, therefore, from the upper and fore part of the foramen magnum, and the concavity of the basilary process of the occipital bone, descending from thence, within the vertebral canal on the posterior surface of the bodies of the vertebræ, to the sacrum. It first passes behind the odontoid process, and extends laterally in its passage over the posterior surface of the intervertebral substance. None but minute vessels can be traced to it, nor is its structure so fibrous as that of the common anterior ligament. In the cervical and dorsal regions, it is thicker than in the lumbar. The posterior surface of this ligament is in contact with the dura mater, covering the spinal marrow, to which it is connected by loose cellular membrane. The anterior surface is attached to the bodies of the vertebræ, and to the intervertebral substance, and is very firmly connected with the latter. Its lateral edges are parallel to the sinus venosus. This ligament prevents the spine from being bent too much forwards.

Intervertebral substance.—The structure of this substance partakes of the nature of ligament and cartilage; it occupies the spaces between the bodies of all the vertebræ, corresponds in shape with the bodies of those which it connects, and, like them, differs in the different regions, gradually increasing in density, and separating the vertebræ more widely as it approaches the sacrum. In the cervical and lumbar regions, this substance is found thicker anteriorly than posteriorly; while, in the back, it is thinner anteriorly; thus accommodating itself to the natural curvitures of the spine. It is composed of oblique concentric lamellæ, which are stronger in the external circumference than in the centre, where it is almost fluid; it has, therefore, so little compressibility, as to allow the free motions of the vertebræ upon one another, as if they moved upon a pivot; and, at the same time, diminishes concussion under the violent motions of the spine. It is closely attached, at its edge, to the bodies of the vertebræ; and is so elastic, that man loses somewhat of his height, towards evening, from the pressure to which this substance is subjected in an erect posture during the day. Its strength is such, its attachment so perfect, and its resistance so great, that it will allow even bone to give way, rather than yield itself, to the application of force. Its anterior surface is in contact with the common anterior vertebral ligament, with which it is firmly connected; laterally, with the inter-articular ligament of the ribs; and posteriorly, with the common posterior vertebral ligament. In old age, this structure becomes dry and shrivelled, so as to diminish the height of the person; and it also, in a great measure, loses both its flexibility, and elasticity. The combined flexibility and elasticity of this structure admits, at the same time, both the variety of motion and strength of the spinal column.

Mode of Connexion of the Arches of the Vertebræ.

The bony arches of the vertebræ do not form articulations with each other, but are connected by means of a very elastic ligamento-cartilaginous structure, termed the *ligamentum sub-flavum*, which fills up the spaces between them, and allows of extensive motion between one arch and another. The first of these ligaments is found between the second and third cervical vertebræ, and the last between the fifth lumbar and the first bone of the sacrum. It is divided into a right and left portion by some intervening cellular membrane, but united at an angle posteriorly, near the base of the spinous process. In the fœtus, this ligament is separated into two distinct portions, which probably do not unite until the ossification of the spinous processes has been perfected. It differs from all other ligaments in being extremely elastic, and capable of resisting an extraordinary degree of force. Its anterior face is in contact with the dura mater of the medulla-spinalis; posteriorly, it is of a reddish tint, and is with difficulty perceived without producing flexion of the spine, in consequence of its being so much covered by the arches of the vertebræ, particularly in the dorsal region. These ligaments are very strong, short, and of a yellowish red colour; possessing such a degree of elasticity, as to assist the muscles in recovering the erect posture, after the spine has been flexed.

Articulation of the Articular Processes.

CLASS *Diarthrosis.*—SUBDIVISION *Arthrodia.*

The faces of the articular processes are covered with cartilage, and are connected by synovial membrane, which forms a very small capsule, and secretes but an inconsiderable quantity of synovia. On the exterior there are some ligamentous fibres, which connect the processes more firmly together, and produce an irregular capsular ligament, which is more visible in the dorsal, and lumbar, than in the cervical region. The inner edge of this capsule is connected with the ligamentum subflavum.

Cervical ligament.—The cervical ligament arises from the perpendicular spine of the occiput, and is inserted into the spinous process of the five superior cervical vertebræ. It is much stronger in quadrupeds than in man; as, from their horizontal posture, such a structure is essentially necessary to support the weight of the head. In man, it appears to be of little more use than to give attachment to muscles, although it may, in some degree, assist in maintaining the proper position of the head in the erect posture.

Interspinous ligaments.—These ligaments extend from the apex of one spinous process to that of another, and are situated immediately under the skin. They commence at the sixth cervical vertebra, and extend as far as the sacrum. Laterally, they intermix with the tendinous origins of the trapezius, and latissimus dorsi muscles. These ligaments are sometimes described as occupying a considerable portion of the length as well as the apices of the spinous processes; but it appears that the structure in that situation, is merely the tendinous origin of muscles.

In the dorsal vertebræ there are some fibres of ligamentous appearance, situated between the transverse processes, which have been called *intertransverse* ligaments, but which do not deserve such a classification, as they seem rather to be the origin of the levatores costarum, and multifidæ spinæ, than proper ligaments.

The Peculiar Articulations of the Vertebræ.

Articulation of the Head with the Vertebral Column.

CLASS *Diarthrosis.*—SUBDIVISION *Arthrodia.*

This articulation forms a double arthrodial joint, produced by the condyloid processes of the occiput, being received into the articular surfaces of the atlas; both of which are covered with cartilage and synovial membrane, and are connected by the following ligaments, which retain them firmly in their situation.

The *anterior portion of the circular ligament,* is attached above to the fore part of the foramen magnum, and extends itself to the anterior extremities of the condyloid processes; it thence passes down and is inserted into the fore part of the arch of the atlas, becoming there continuous with the common anterior vertebral ligament, and also into the edges of the articular surfaces of that bone.

Posterior portion of the circular ligament.—This ligament is much larger than the anterior; it arises from the posterior margin of the foramen magnum, extending itself laterally as far as the capsular ligament, connecting the occiput with the atlas, and then passes down to be inserted into the upper part of the posterior arch of the atlas. This ligament has in contact with its posterior surface, the straight and superior oblique muscles of the head, the vertebral arteries, and sub-occipital nerves.

The *capsular ligaments,* which strengthen the articulation of the condyles of the occiput with the atlas, are attached to the circumference of the articular processes of both these bones; they are looser anteriorly and posteriorly, than at the sides, and allow therefore but of little lateral motion.

The *synovial membrane* covers the occipital condyles and articular processes of the atlas, lining at the same time that part of the internal surface of the anterior and posterior circular ligaments, which is in contact with those portions of bone, and thus assists in forming the capsular ligaments, for the more perfect security of this articulation. The synovial membrane is also attached, on its inner side, to the transverse ligament of the atlas.

Connexion of the Vertebra Dentata with the Occiput.

These bones are not in actual contact so as to form a joint, but they are kept in their relative situation by the two *lateral* or *alar ligaments,* which arise connected with each other from the body and sides of the odontoid process, reaching as far as its apex; from which point they pass on either side upwards and outwards, to be inserted between the inner edge of the condyloid processes and the foramen magnum of the occipital bone. They are for the purpose of preventing the head, with the atlas, being rotated too forcibly and extensively upon the vertebra dentata.

Articulation of the Atlas with the Vertebra Dentata.

CLASS *Diarthrosis.*—SUBDIVISION *Trochoides.*

The ligaments which form the articulation between the atlas and the second cervical vertebra, or the vertebra dentata, are *first*, the transverse ligament, which is proper to the atlas; and *secondly*, the ligaments of the articular processes, which are common to all the vertebræ.

The *transverse ligament* arises from a rough tubercle on the inner side of the articular process of the atlas; then forming an arch, which encloses the odontoid process of the second cervical vertebra, by passing behind it, is directed transversely, to be inserted into the inner side of the opposite articular process. The middle fibres which are in contact with the dentiform process, are the strongest; and from this part two appendices issue; one placed superiorly, and the other inferiorly; the superior one, passing along the odontoid process, is lost just above its apex in the fibres of the common posterior ligament of the vertebræ; the inferior appendix arises from the inferior edge of the transverse ligament, passes downwards in connexion with the lower part of the odontoid process, and is also imperceptibly lost amid the fibres of the common posterior vertebral ligament. The transverse ligament, together with the appendices, form a cross; between the anterior part of which, and the odontoid process, is a *synovial membrane*, which is sufficiently loose to allow of free rotatory motion between the first and second cervical vertebræ. There is also a synovial membrane covering the cartilaginous surfaces, upon the fore part of the odontoid process and arch of the atlas.

The capsular ligaments connecting the articular surfaces of these bones need no further description, as they have already been mentioned amongst those common to the vertebræ.

Motions of the Spine.

With respect to this function of the spine, there are three ways in which it may be considered. *First*, its general mobility as a whole; *secondly*, the peculiar motions of each region; and *thirdly*, the mobility which exists between any two particular vertebræ.

The general motions of the vertebral column are those of *flexion*, *extension*, *lateral inclination*, *circumduction*, and *rotation*. The most extensive motion of which the spine is capable, is *flexion;* for although the degree of motion between any two vertebræ is extremely limited, still, as that motion is multiplied by the number of vertebræ the flexibility of the whole column becomes very considerable. The lower extremities being fixed, the abdominal muscles draw the ribs forwards and downwards, and the whole trunk is bent, so as to form a parabolic curve. In this action the common anterior ligament is relaxed, the fore part of the inter-vertebral substances is compressed, while their posterior edges are stretched; and the common posterior ligament of the vertebræ, together with the interspinous ligaments, are in a state of extension.

In *extension*, the ligaments are placed precisely in the reverse state to that which they assumed in flexion; those which were extended being in their turn relaxed while the common anterior vertebral ligament is now put upon the stretch: this motion is more confined than that of flexion, in consequence of the spinous processes of the dorsal vertebræ being soon brought into apposition, in which state no further extension is possible.

In the *lateral inclination*, the inter-vertebral substances are compressed on that side to which the body is bent; the other ligaments are scarcely altered from their natural state; as the motion is restricted by the resistance which is offered by the ribs, and the transverse processes of the vertebræ, so as to be too inconsiderable to affect them.

Circumduction is produced by the succession of the other motions, and the ligaments undergo the changes peculiar to each motion, as rapidly as it occurs.

The *rotatory* motion of the spine is very limited in all the vertebræ, but more particularly in the dorsal, in consequence of their attachment to the ribs. In this motion the inter-vertebral substance is contorted, as are likewise all the ligaments.

The motions of the spine are capable of being infinitely extended by the motion of the pelvis upon the thighs.

Motions peculiar to each Region.

The extent of motion in the several regions of the spine is in proportion to the thickness of the inter-vertebral substance; it is, therefore, much greater and more extensive in the cervical and lumbar regions than in the dorsal, in which it is not only impeded by the comparative tenuity of the substance, but also by the oblique directions of the spinous processes of these vertebræ, and their attachment to the ribs. The reason for the stability of this region is obvious, when we consider the important organs which the dorsal vertebra assist in enclosing, and that extensive motion would necessarily interfere with their functions.

Motions between particular Vertebræ.

The free motion of one vertebra on another is particularly exemplified in the first and second cervical. The occiput is so articulated with the atlas, that flexion, extension, and, in a slight degree, lateral motion, are allowed between them; but if there be necessity for these motions to any extent, the whole of the cervical vertebræ participate in them. It is, however, in the rotatory motion of the head, that the first and second cervical vertebræ act upon one another; and the species of articulation formed by these two bones shews how well they are calculated for that purpose, and how essential they are in the performance of most of the animal functions: for they may justly be said to increase and regulate the powers of vision, smell, and hearing; and by shortening and prolonging the trachea, alter the tones of the voice, and assist in producing a free passage of air to and from the lungs.

Practical Remarks.

The number and breadth of the attachments of these bones,—their firm union by ligament,—the strength of their muscles,—the very inconsiderable degree of motion which exists between any two of them,—and lastly, the obliquity of their articular processes, especially in the dorsal and lumbar vertebræ, render dislocation of them, at least in those regions, impossible without fracture. In the cervical region dislocation of these bones does sometimes happen and without fracture. Boyer has not only related cases of dislocation of the atlas from the vertebra dentata, but has also described the means to be employed for their reduction. A case is also related in the *Medical Gazette* of the 22nd of January, 1831, of dislocation of the sixth from the seventh cervical vertebra. The patient was admitted into the London hospital, and died the following day.

The effects of such an accident, whether with, or without fracture, would produce precisely the same injury to the spinal marrow, and symptoms of greater or less importance, according to the part of the spinal column that is injured. Death is the immediate consequence, if the injury be above the third cervical vertebra; the necessary paralysis of the parts to which the phrenic and intercostal nerves are distributed, causing respiration instantly to cease. If the injury be sustained below the fourth cervical vertebra, the diaphragm is still capable of action, and dissolution is protracted; the symptoms, in fact, are less violent in proportion as the injury to the spinal marrow is farther removed from the brain; but death is the inevitable consequence, and that in every case, at no very distant period. Indeed, the diagnosis and prognosis are the same as have been described in speaking of fractures of the vertebræ.

In hydrocephalus the fluid sometimes passes down from the brain into the spinal marrow, and produces a tumour in the course of the spinal column usually in the lumbar region. This disease is termed spina bifida, and is generally concomitant with malformation of the vertebræ, the spinous processes being deficient at the part where the tumour protrudes. Spina bifida is frequently congenital, and probably the imperfection of the vertebra depends upon the pressure of the fluid preventing the formation of the spinous processes. This disease is of a very incurable nature If pressure be made upon the tumour, so as to force the fluid into the spinal sheath, the brain becomes immediately affected; or if the fluid be discharged in the manner recommended by Sir Astley Cooper, namely, by repeated small punctures, and at the same time employing pressure by means of a truss, some hopes may be entertained of a radical cure, although the prognosis must always be considered as unfavourable. Sir Astley Cooper has, however, published in the *Medico Chirurgical Transactions*, three successful cases under his own care.

One of the most distressing diseases to which the spine is liable is rickets, leading to such distortions of the spinal column as to interfere with the vital functions; and this may arise either from a deficiency in the components of the bones, or from some unnatural action being set up in them. The incurvations of the spine, when the effect of rickets, is always lateral, but when produced by ulceration of the bodies of the vertebræ, the spine is bent forwards: either of these distortions may produce pressure on the spinal marrow, and consequent paralysis, if the deviation from the natural form of the spine be excessive. These symptoms indicate the necessity of taking the superincumbent weight off the spine, and various apparatus have been invented for this purpose; but as most of them are so constructed as to remove the weight to some other part of the osseous system, as on the pelvis, the liability to injury of these bones in such constitutions, only removes the effects of the disease from one part to another; and therefore most of these mechanical instruments are to be deprecated, and such only should be employed as are fixed to chairs, or the ceiling, so that the patient has not to support the additional weight. The recumbent posture on an inclined plane, for a certain period every day, should also be enjoined, and the exercise of such muscles as have a tendency by their action to restore the spine to its natural position. It is unnecessary to point out the propriety of paying every attention to the general health of the patient, more particularly in reference to the kind of food, the salubrity of the air, and the state of the digestive organs.

Articulation of the Ribs with the Bodies of the Dorsal Vertebræ.

CLASS *Diarthrosis.*—SUBDIVISION *Ginglimus.*

In the osteological description of the dorsal vertebræ, all excepting the first, tenth, eleventh and twelfth, are said to have a half articular surface on the upper, and on the lower part of their bodies, for the head of a rib, which is furnished with two corresponding half articular surfaces, separated from each other by a small ridge: each articular surface is covered by cartilage. They are surrounded by a synovial membrane; and the following particular ligaments connect them firmly to the vertebræ.

Anterior ligament to the head of the rib.—This ligament surrounds the anterior part of the head of the rib, and then, in all excepting the first, eleventh, and twelfth, divides itself into three orders of fasciculi; one passing upward to the articulation of the rib with the vertebra above, another passing to the vertebra below, and the third central fasciculus attaching the rib to the inter-vertebral substance: thus every rib is firmly attached to two of the vertebræ, and to the inter-vertebral substance. The anterior face of this ligament is covered by the thoracic ganglia of the sympathetic nerve, and by the pleura; on the right side also, by the vena azygos; and, posteriorly, it is in contact with the synovial membrane of the articulation of the ribs with the vertebræ, for which it forms a capsule.

The *inter-articular ligament* enters into the articulation of all the ribs, from the second to the tenth inclusive, and is apparent on raising the middle fasciculus of the former ligament. It arises from a small tubercle situated between the two articular surfaces on the head of the rib, and passes to be attached to the inter-vertebral substance.

The *synovial membrane* is reflected upon the half of the articular surface of the rib and vertebra, both above, and below, forming two distinct bags, which are separated by the inter-articular ligament. The synovial secretion is very limited.

Articulation of the Tubercle of the Rib to the Transverse Process of the Vertebra.

CLASS *Diarthrosis.*—SUBDIVISION *Arthrodia.*

This joint exists in all the ribs excepting the eleventh and twelfth, and is formed by the contact of these two parts, both of which are covered with cartilage. They are furnished with a small synovial cavity, which secretes more synovia than that of the preceding articulation. The following ligament concurs in fortifying this joint.

The *external transverse ligament* arises from the apex of the transverse process of each dorsal vertebra, and passes outwards to be inserted into the neck, reaching as far as the angle of each rib. These ligaments gradually increase in size as far as the ninth rib, which is the longest from its tubercle to its angle, and is composed of fasciculi of great strength. With regard to the twelfth rib, the ligament passes obliquely downwards, to be inserted into its body; serving, by its attachment, to connect it with the transverse process of the vertebra; indeed, they are connected solely by this medium, having no articulatory surface in contact.

The *use* of this ligament is to prevent the rib from being thrust forcibly forwards from the transverse processes of the vertebræ.

Connexion of the Neck of the Ribs with the Articular, and Transverse Processes.

The *external ligament of the neck of the rib* arises from the external surface of the inferior articular process of the vertebra above, and from the root of the transverse process.

Between these two origins is a space for the passage of some posterior nerves from the intercostals; it then passes downwards, to be inserted into the upper part of the neck of the rib below. It prevents the neck of the rib from being elevated by the action of the intercostal muscles, but allows the head to turn in its capsule, so as to admit of the proper adjustment and elevation of the body of the rib in inspiration.

The *internal ligament of the neck of the rib* arises from the anterior surface of the transverse process of the next superior vertebra, and passes downwards to be inserted into the fore part of the neck of the rib immediately below; it is attached, therefore, in a very similar manner to that of the external ligament of the neck of the rib, excepting that it is situated anteriorly, and its fibres pass somewhat more inwards, so as to decussate with those of the external ligament.

Articulation of the body of the Rib to its Cartilage.

There are some anterior and posterior ligamentous fibres, which pass from the bodies of all the ribs to their respective cartilages, and connect them firmly together. The cartilages of the seven superior ribs pass forwards, to be attached to the sternum, with which they are connected by an anterior and posterior ligament, and synovial membrane.

The *anterior ligament* is fixed to the extremity of the cartilage; it then passes, with its fibres diverging, to be fixed to the anterior part of the sternum, upon which it spreads itself, and interlaces with those of the opposite side, and with the periosteum, as well as with the anterior ligament of the cartilage of the rib above and below it, so as to form a complete ligamentous covering to the sternum. This decussation of the fibres is more particularly obvious at the union of the sixth and seventh cartilaginous articulations with the sternum, than at any other part.

The *posterior ligament* is not so thick as the anterior, but is attached, like it, to the cartilages of the ribs, and to the sternum; while, on its posterior surface, it diverges and interlaces with the ligaments above and below, and with the periosteum, forming a complete posterior covering to the sternum.

The *synovial membrane* which covers the articular surface of the cartilage of the rib and of the sternum, is extremely small; and were it not for the occasional occurrence of an inordinate secretion of synovia, the result of inflammation, its existence might almost be doubted. The seventh rib being attached to the cartilago-ensiformis, its ligament is sometimes called the *ligamentum ensiforme*.

Articulation of the False Ribs.

These bones are all connected together by their cartilages excepting the last, which is only attached by muscle. Their union appears to be produced by anterior and posterior ligamentous fibres, similar to those which connect the true ribs to the sternum, but they are not so strong.

Ligamentum arcuatum arises from the apices of the transverse processes of the two upper lumbar vertebræ, and passes upwards and outwards to be attached to the acute edge of the last rib throughout its whole extent.

Articulation of the Bones of the Sternum.

Besides the ligaments which have been described as passing from the cartilages of the ribs to the sternum, there are proper ligaments connecting the three bones of the sternum, which principally pass in the longitudinal direction upon its anterior and posterior surfaces, and cover those ligaments which attach the cartilages of the ribs to the sternum. They may be termed the *proper, anterior*, and *posterior ligaments of the sternum.*

Practical Remarks.

From the numerous ligaments which connect the ribs to the vertebræ, and the improbability that sufficient force should ever be applied to a rib to produce dislocation, it is an accident that seldom occurs. Should it happen, however, that the head of a rib were detached from the vertebræ by any violence, the same symptoms would present themselves as in cases of fracture, and would require the same mode of treatment.

For my own part, I do not believe in the possibility of dislocation of the rib from the vertebræ, unless there has been some prior disease, which has partly destroyed its ligamentous connexions; on the contrary, I am disposed to conclude, that a rib sustaining such a degree of violence as might be supposed capable of dislocating it, would be invariably fractured at its neck. Such I find to be the case in experiments upon the dead body; for though the rib be subjected to the application of force, by means of an instrument best calculated to detach its head from the articulation, yet it is always broken. The cartilages are sometimes separated from the bodies of the ribs, and from the sternum; but this is more frequently the result of distortion of the spine, and consequent gradual displacement, than of any sudden violence.

Articulations of the Superior Extremity.

The shoulder is united by means of the clavicle with the sternum, through the medium of an inter-articular cartilage, but the scapula is only connected with the trunk by muscle; the sterno-clavicular articulation forms the fulcrum for the whole of the upper extremity to move upon the trunk.

Articulation of the Clavicle to the Sternum.

CLASS *Diarthrosis.*—SUBDIVISION *Arthrodia.*

The sternal extremity of the clavicle is concave, and is placed rather above the articular surface of the sternum; these two surfaces are covered by cartilage. This articulation is constituted by four ligaments; an *anterior*, a *posterior*, an *inter-clavicular*, and a *costo-clavicular*, or *rhomboid;* and by an *inter-articular cartilage.*

The *anterior ligament* is composed of strong fibres, which run in parallel lines from the upper extremity of the clavicle to the anterior face of the first bone of the sternum: there its fibres diverge and mix with the ligaments connecting the first rib, and assist in forming the anterior ligamentous sheath of the sternum. Its posterior face is united firmly to the inter-articular cartilage, and to the synovial membrane; its anterior surface corresponds to the origin of the sterno-cleido mastoideus muscle, and the integuments.

The *posterior ligament* is neither so large nor so strong as the anterior; it is united above to the posterior part of the internal surface of the clavicle, and below to the superior and posterior surface of the sternum, being firmly attached to the edge of the articular surface. The anterior portion of this ligament, is in contact with the inter-articular cartilage and the synovial membrane; the posterior, covers and gives partly origin to the sterno-hyoideus, and thyroideus muscles.

Inter-clavicular ligament.—This ligament is strong, and is composed of parallel fibres which run transversely from the head of one clavicle to the head of the other, above the concave semilunar edge of the sternum. It is sometimes composed of two fasciculi, an upper and a lower, but usually only of one. It is connected on the heads of the clavicles with the sterno-clavicular articulations; and by its lower edge, as it passes above the upper part of the sternum, it is attached to its periosteum by cellular membrane.

The *use* of this ligament is not only to connect the clavicles firmly with each other, but also to strengthen their articulation with the sternum. It also assists in protecting the trachea, as it passes through the upper opening of the chest.

The *rhomboid ligament* is connected firmly with the inferior surface of the clavicle, and with a small tubercle close to its sternal extremity. It is strong and broad, and passes obliquely downwards and forwards to be inserted into the anterior part of the cartilage of the first rib, close to its junction with the sternum, and mixes with the ligament which connects them.

The *use* of this ligament is principally to fix the clavicle for the action of the sterno-cleido mastoideus, and to give attachment to the subclavius muscle.

Inter-articular cartilage.—This cartilage is very nearly circular, having a smooth surface above for its attachment to the clavicle, and one below for the sternum. It is thick and rough at its circumference, and comparatively thin in its centre. It adjusts itself to the articular surfaces of both the clavicle and sternum, extending as far on the latter bone as the attachment of the cartilage of the first rib, with which it is firmly connected. This cartilage is in the form of a wedge with its base turned upwards to the clavicle, and its apex descending obliquely to be connected with the first rib. In structure it resembles the inter-articular cartilage of the lower jaw; its fibres being more apparent at the circumference than at the centre.

Synovial membrane.—This membrane is separated, as in the instance of every joint where there is an inter-articular cartilage, into two synovial cavities; the upper one belonging to the articular surface of the clavicle, and the superior face of the inter-articular cartilage; the lower one being between the sternum and the cartilage. They are reflected over the internal surfaces of the anterior and posterior sterno-clavicular ligaments. They secrete but an inconsiderable quantity of synovia, and sometimes the two cavities are united, by an opening through the cartilage.

The upper synovial or clavicular capsule admits of motion upwards and downwards, while the lower or sternal capsule admits of backward and forward motion; and therefore we find in this, as in all other joints where there is an inter-articular cartilage, that not only strength is added to the articulation, but that also its motions are rendered at least more varied, if not more extensive.

Articulation of the Clavicle with the Scapula.

This articulation is strengthened by the following ligaments, which may be divided into those which attach the clavicle to the acromion, and those which connect it with the coracoid process of the scapula. This latter junction is produced by ligament only, there being no bony continuity; while, in the former, the surfaces of bone are in juxta-position, presenting superior and inferior surfaces, which give attachment to corresponding ligaments.

Articulation of the Clavicle with the Acromion.

CLASS *Diarthrosis.*—SUBDIVISION *Arthrodia.*

This joint is furnished with a superior and an inferior ligament, and also with a synovial capsule.

The *superior ligament* is composed of very strong fasciculi, which pass from the upper surface of the clavicle to the extremity of the acromion, and expose a surface for the tendinous insertion of the trapezius, and for the origin of the deltoid muscle.

Inferior ligament.—This ligament, anteriorly, is in contact with the preceding; it then passes on the under surfaces of the clavicle and acromion, but does not extend so far backwards as to be connected with the posterior edge of the superior ligament; its inferior surface is in contact with the infra-spinatus muscle, while its superior surface is connected with the synovial membrane of this articulation. It is so loose as to allow of some degree of motion independently of the scapula.

Synovial membrane covers the articular surfaces of both bones, but secretes very little synovia; it is sometimes divided into two cavities by an inter-articular cartilage; this, however, is but of rare occurrence.

Junction between the Clavicle and Coracoid Process of the Scapula; or, Coraco Clavicular Union.

Their union is formed by two ligaments, which connect the clavicle with the coracoid process. They arise by a single origin from the coracoid process, but separate into two portions to be inserted into the clavicle, which admits of their being described as two distinct ligaments — the *conoid* and the *trapezoid.*

The *conoid* is the posterior and internal of the two; it is of a conical form, with its base upwards, which is attached to the tubercle at the under part of the clavicle, its apex being connected with the coracoid process.

The *trapezoid* is anterior and external; it is broader than the conoid ligament, but not so strong; it extends from the middle of the convexity of the coracoid process, passes upwards and outwards, to be attached to the under surface of the scapular extremity of the clavicle, close to the connexion of this bone with the acromion. The connexion formed by these ligaments is strong; but, at the same time, they are sufficiently loose to admit of the scapula performing several of its motions without the clavicle: they also serve, under very violent exercise, or in case of a blow, to prevent an immoderate depression of the scapula; for their strength is such as to resist violence, even to that degree which may cause the fracture of the clavicle.

Ligaments proper to the Scapula.

There are two ligaments proper to the scapula: the *anterior*, or *acromio-coracoid;* and the *posterior*, or *coracoid.*

The *anterior*, or *acromio-coracoid ligament*, is triangular; it arises by its base from the outer side of the coracoid process, and is inserted by its apex into the inner side of the acromion. It is attached to the whole length of the external edge of the coracoid process, from which it sometimes passes in two fasciculi to the posterior edge of the acromion; but the space between the two is filled up by condensed cellular membrane. The anterior edge of this ligament gives off a strong fascia, which is attached to the under part of the deltoid muscle, and to the tendons of the supra and infra spinati. Its superior surface is covered by the clavicle, and deltoid muscle; the inferior surface covers the supra-spinatus. This ligament, passing from the acromion to the coracoid process, forms an arch over the head of the os humeri, which is usually said to assist in preventing dislocation of the os humeri upwards. This dislocation, however, is rendered impossible by the proximity of the acromion and coracoid processes, unless one or other of these processes be fractured; so that this ligament seems rather useful in presenting an extended surface for the origin of muscle, than in preventing dislocation.

The *posterior*, or *coracoid ligament*, arises from the superior costa of the scapula, passes over the semilunar notch, which it forms into a foramen, and is attached to the root of the coracoid process: it is broader posteriorly than anteriorly. It gives origin in part to the omo hyoideus muscle, covers the supra-scapular nerve, which passes through the foramen, while the supra-scapular artery takes its course above the ligament, and is consequently separated from the nerve by it: both the nerve and the artery, in passing to their destination, are situated in front of the origin of the omo hyoideus muscle.

Motions of the Clavicle.

I am now to describe the numerous and different motions of which the clavicle is capable, and from which it might *a priori* be supposed, that this bone would be very frequently liable to dislocation; in consequence, however, of the many strong ligaments which connect it at its sternal and scapular extremities, its luxation happens less frequently in proportion to its motions, than of any other bone in the body.

The motions of the clavicle are principally dependant upon those of the scapula, which is capable of being moved upwards, downwards, forwards, and backwards; and from the combination of all these movements, it likewise admits of circumduction.

Although the scapular extremity of the clavicle receives the first impulse from muscular power, still it is at the sternal extremity that the ligaments sustain the greatest change under these various motions.

First, upwards.—When the shoulder is raised by the elevation of the scapula, the sternal extremity of the clavicle is thrust deeply into the articular cavity, and thus its inter-articular cartilage is brought nearer to the surfaces of the clavicle and sternum; the rhomboid, or costo-clavicular ligament being put upon the stretch, prevents luxation and further motion; while the inter-clavicular, anterior, and posterior ligaments, are relaxed.

Secondly, downwards.—In this motion, the ligaments are precisely in an opposite state to the preceding.

Thirdly, forwards.—It is in this motion that the clavicle is most liable to be luxated backwards at its sternal extremity; but in consequence of the strength of the posterior and inter-clavicular ligaments, which are put upon the stretch, this accident is prevented; the anterior ligament is necessarily relaxed, but the rhomboid or costo-clavicular ligament remains in its natural state.

Fourthly, backwards.—In this motion the scapular extremity of the clavicle is drawn backwards, while its sternal extremity is thrust forward, and stretches the anterior sterno-clavicular ligament. If at this moment the shoulder were violently thrust still farther backward, the sternal extremity of the clavicle might be dislocated forwards; but the rarity of this accident is in consequence of the strength of the inter-clavicular, and posterior ligaments, which are put upon the stretch.

Lastly.—With respect to circumduction, it is a quick succession of all these motions; during which, the ligaments adapt themselves with rapidity to their alternate states of relaxation, and extension.

Practical Remarks.

The clavicle may either be dislocated from the sternum, or from the acromion process of the scapula; but fracture of this bone much more frequently happens than displacement of its articulatory surfaces.

The dislocation of its sternal extremity may occur in three directions; either forwards, backwards, or upwards: but dislocation downwards cannot happen, in consequence of the attachment of the inter-articular cartilage to the first rib.

It is the dislocation *forwards* which is most frequent, and generally occurs from the application of force upon the shoulder, when the arm is carried to its fullest extent backwards,—a direction in which it is most capable of being moved: at this time, the sternal extremity of the clavicle is thrust forcibly against the anterior ligament, which may give way, and the articular surface of the clavicle pass on the upper and fore part of the sternum. It is not, however, the strength of the anterior ligament only, which prevents the frequent occurrence of this accident, but also the attachment of the m. sterno cleido mastoideus. The diagnosis in this accident is very easy, in consequence of the superficial situation of the bone affected. The extremity of the clavicle is readily felt and seen in its new situation; the shoulder seems to fall upon the chest, and the patient loses the power of raising his arm, from the loss of its fulcrum.

When the dislocation occurs *backwards*, it is produced by the scapula being thrust violently forwards, by which force the sternal extremity of the clavicle is thrown behind the upper part of the sternum. This accident is of a much more serious nature than the last described, as all the sterno-clavicular ligaments, and even the costo-clavicular, must be torn through to admit of this displacement: it is therefore, as may be supposed, of but rare occurrence. This accident may produce most serious symptoms, from the bone pressing upon the trachea, œsophagus, and vessels of the neck, as has been described by Petit and Sir Astley Cooper, rendering it necessary, in some cases, to saw off the extremity of the bone,—an operation which has been performed by Mr. Davy, a surgeon in Suffolk. In the performance of this operation considerable difficulty and danger must occur in removing the displaced sternal extremity of the bone, which would be buried deeply behind the sternum, and in close proximity to the large blood-vessels of the neck. Might not the operation be infinitely simplified by taking away a portion of the centre of the clavicle, and thus prevent the scapula thrusting the clavicle inwards upon the trachæa and œsophagus; at the same time that you avoid the danger of injury to the carotid artery and jugular vein.

The dislocation *upwards* is affected by a sudden and violent depression of the shoulder, which allows the extremity of the clavicle to pass above the upper bone of the sternum, and to approach the clavicle of the opposite side, necessarily diminishing the space between them, and relaxing the inter-clavicular ligament. The diagnostic marks of these displacements are sufficiently conspicuous, from the circumstances alluded to in the dislocation forwards.

The mode of reduction of a dislocated clavicle is similar to the means used in fracture of that bone: by placing a pad in the axilla, and making a lever of the humerus; by bringing the elbow to the side, the shoulder is carried outwards where the scapula should be fixed with a direction either backwards, forwards, or upwards, depending on the position of the dislocated clavicle.

Dislocation of the scapular extremity of the clavicle is less frequent than that of the sternal extremity, but it does occur in two directions, so that the clavicle may either be thrown *above* or *below* the acromion process of the scapula. The displacement upwards is by far the most frequent, in consequence of the form of the articulatory surfaces; it is produced by a fall on the point of the shoulder, which is driven downwards, so that the clavicle, losing its attachment to it, slides on the upper surface of the acromion. In this dislocation the superior and inferior acromio clavicular, as well as the coraco clavicular ligaments, are torn through. The nature of the accident is easily understood, not only from the superficial situation of the parts, but also from the loss of motion of the extremity; for the patient has great intolerance to any motion of the arm, as it calls into action the deltoid and trapezius muscles, which move the dislocated bones, and consequently produces great pain.

This dislocation is reduced in the same manner as described in luxations of the sternal extremity, but there is more difficulty after the reduction is completed, in keeping the bone in its situation; therefore, particular attention should be paid to the application of the bandages; for should the bone remain unreduced, the motions of the whole extremity are impeded, and the patient remains for life, more or less disabled.

Articulation of the Humerus with the Scapula.

Class *Diarthrosis.*—Subdivision *Enarthrodia.*

The bones which enter into the composition of the shoulder-joint, are the scapula and the humerus; the head of the latter being received into the glenoid cavity of the former, and there retained in its situation by ligaments. This articulation is usually classed as arthrodial; but the depth of the glenoid cavity when furnished with its ligament, the form of the head of the humerus, and the arrangement of all its ligaments, render the joint more similar to a ball and socket than a plane-form articulation. On examining the glenoid cavity of the scapula in the recent state, we find it rendered deeper by a fibro-cartilaginous substance, which surrounds its edge, and is attached to the tendon of the long head of the biceps muscle; this is called the *glenoid ligament;* it assists in retaining the head of the humerus in its situation, and also gives extent of surface for the attachment of the synovial membrane.

Before I enter upon a description of the ligaments, I would direct the attention of the student to the peculiar construction of this joint, which excels all others of the body in its extent and variety of motion. This superiority arises, in a considerable degree, from the action of the numerous muscles inserted into the scapula, which is thus endowed with a mobility peculiar to itself. It is also owing to the form of the articulatory surfaces of that bone and the os humeri, which are most effectually adapted to the above purposes; the ligaments also are sufficiently loose to allow full play to the bones while under the influence of muscles; which combined circumstances, render this joint so particularly liable to dislocation. Thus we find that anatomy, physiology, and even pathology, all tend to illustrate the different functions of this joint.

Capsular ligament.—This ligament envelopes the joint. It arises from the neck of the scapula, and adheres to the glenoid ligament, over which it passes; then expands itself to surround the head of the os humeri, and contracts again, as it extends downwards, to be inserted into the neck of the humerus; reaching as far as the tubercles of this bone, where it is inseparably connected with the tendinous insertions of the teres minor, spinati and subscapularis muscles. This capsule, where it extends from the greater to the smaller tubercle of the humerus, leaves a foramen for the passage of the tendon of the long head of the biceps muscle.

The capsular ligament is not of a uniform thickness, being thinnest on its outer and hinder part; but here it is strengthened by the tendons of the teres minor and infra-spinatus muscles. On the inner side towards the axilla, where there is no tendinous expansion to give it support, it is found sufficiently strong and unyielding to prevent the displacement of the head of the humerus in that direction by any ordinary force. Besides the support which this ligament receives from the tendons of muscles, it derives additional strength from strong fasciæ, which extend from the acromion and coracoid process of the scapula; it is especially fortified by a fascia from the anterior part of the triangular or coraco acromial ligament, which is found immediately underneath the belly of the deltoid muscle; and further, by the *accessory ligament*, which is situated on the fore and inner side of the articulation, proceeding from the coracoid process of the scapula to the greater tuberosity of the humerus, connecting itself with the tendon of the infra-spinatus muscle. We find that the capsular ligament of this joint is more lax than is necessary for the mere junction of the two bones which it connects, in order to allow the free and various motions of which the shoulder-joint (constituted, as its form shews, rather for mobility than strength), is so capable.

The capsular ligament, then, appears to be of as much service in giving attachment to the synovial membrane, which completely lines it, as in preventing the dislocation of the head of the os humeri. Of the four muscles which are inserted into the capsular ligament, the tendon of the subscapularis is most completely blended with it, so that it is not practicable to separate them without laceration. This tendon seems even to pierce the capsule, in order to gain its insertion into the smaller tubercle of the humerus.

The *glenoid ligament* is composed of fibro-cartilaginous tissue, and forms a rim around the articulatory surface of the scapula, which it renders deeper. It derives its fibrous texture from the tendon of the long head of the biceps, which arises from the summit of the glenoid cavity of the scapula, splits equally into two sets of fibres, and pass on either side into the substance of the glenoid ligaments, to meet a similar disposition of the tendinous origin of the long head of the triceps from beneath; thus forming, in conjunction with the insertion of the subscapularis muscle, the fibrous texture of the glenoid ligament. Its cartilaginous texture is produced by a continuation of the permanent or articular cartilage of the scapula. The form of the glenoid ligament is elliptical, its base is attached to the circumference of the glenoid cavity, and its apex terminates in a thin free edge.

Synovial membrane.—This membrane lines the glenoid cavity, passes over the glenoid ligament, to which it is attached upon its internal and external surfaces; extends as far back upon the neck of the scapula as the origin of the capsular ligament, which it completely lines; then passes partly under the tendinous insertions of the spinati muscles, covers the cartilaginous head of the os humeri, prolongs itself into the bicipital groove, forming a *cul de sac*, so as to prevent the escape of synovia, by enveloping the tendon of the biceps; then extends itself, by passing inwards, to give a lining to the insertion of the subscapularis muscle. Thus it retains the characteristic of all synovial membranes, forming a complete cavity without an external opening.

The *use* of this membrane is to secrete synovia for lubricating the joint; and this secretion being always proportioned to the mobility of the articulation, the quantity in this instance is very considerable.

Motions of the Humerus on the Scapula.

These motions are not only various in direction, but also very extensive, in consequence of the independent mobility of the scapula.

The humerus is capable of being *raised* or *depressed*, carried *backwards* or *forwards*, *inwards* or *outwards;* of being *rotated;* and a combination of all these directions, which is termed *circumduction*. Hence it is obvious, that numerous muscles serve to perform these different motions, and which, it must be remembered, add much to the strength of the articulation, and prevent, therefore, the frequent occurrence of displacement.

When the humerus is raised to its fullest extent, the head of the bone slides from the upper to the lower part of the glenoid cavity, and presses against the inferior part of the capsular ligament, while its raised shaft is opposed to the acromion process of the scapula: it is in this position that dislocation is most likely to occur; for if any force should propel the humerus backwards, the head of the bone is driven through the lower part of the capsular ligament.

In depression of the shoulder, the head of the humerus is drawn from the glenoid cavity, and the capsular ligament, and tendon of the biceps muscle, are put upon the stretch, which restrain the depression beyond a certain extent, unless the force be sufficient to tear these structures. When the arm is directed behind, the head of the humerus is pressed forward against the capsular ligament, but which is at this part so strengthened by the tendons of the spinati subscapularis and deltoid muscles, that the extent of motion, in this direction, is less than when the arm is carried either forwards or upwards, although this movement is much increased by the mobility of the scapula.

In the forward direction of the arm, the articular surface of the humerus remains in contact with the glenoid cavity of the scapula, unless, at the same time, the arm be directed upwards, when the head of the humerus becomes depressed towards the inferior part of the capsular ligament, as before described.

In the rotatory motions, the head of the humerus turns upon its own axis in the glenoid cavity, and is directed either from behind to before, or from before backwards, as the rotation may be either inwards or outwards.

In circumduction, the head of the humerus successively occupies the various situations which have been described as concomitant with the other motions of the articulation; and the whole of the upper extremity, during the evolution, forms a cone, the base of which is at the hand, and the apex at the shoulder-joint.

Practical Remarks.

From the varied and extensive motions of the shoulder joint, dislocation occurs more frequently than in any other joint in the body; and upon examining the articulatory surfaces of the scapula and humerus in the dry bones, it is difficult to imagine how the motions of the articulation can be performed without displacement; and in recent bones, upon inspecting the glenoid and capsular ligaments, they even seem to form but little obstacle to the separation of the two surfaces.

When, however, we proceed to the investigation of the muscles of the joint, we shall find that some of their tendinous insertions being equally fixed to the capsular and glenoid ligaments as to the humerus itself, simultaneously as they give motion to the arm, so accommodate the structures as to adapt them precisely to the kind of motion which is to take place, and thus tend infinitely to prevent their luxation.

The humerus, however, is liable to be thrown from the glenoid cavity of the scapula in three directions, downwards into the axilla, downwards, forwards, and inwards upon the venter, and downwards, backwards, and outwards upon the dorsum of the scapula. We have in the museum of Guy's Hospital a supplementary articulation, formed from an unreduced dislocation, in which a new glenoid cavity is formed upon the anterior costa of the scapula immediately beneath the origin of the long head of the triceps, so that in this luxation the head of the bone is resting midway between the downward and inward, and the backward and outward displacement. This accident was probably originally a common luxation into the axilla; and upon the subsequent contraction of muscles, the head of the humerus was brought in contact with the scapula, leading to the formation of the new joint.

A partial removal of the head of the humerus from the glenoid cavity is also described by Sir Astley Cooper; in this case, the head of the bone rests against the outer side of the coracoid process; but as this displacement occurs more frequently from disease than accident, or without lesion of the ligaments, it ought, in my opinion, to be considered under the diseases of the joint, requiring rather constitutional means for the restoration of the functions of the articulation, than mechanical means for the adaptation of the bones.

Dislocation Downwards into the Axilla.

This accident most frequently occurs from a person falling sideways, while the arm is widely separated from the body, and the elbow coming in contact with some fixed object; the continued impetus of the body forces the head of the humerus through the inferior part of the capsular ligament, between the subscapularis and triceps muscles.

The patient immediately loses all natural motion in the joint. Upon examination, the affected arm appears lengthened, and is fixed in an oblique position from the body, so that the elbow can neither be brought to the side, nor raised to a right angle with the body. In tracing the humerus upwards, it leads the eye into the axilla and not to the glenoid cavity. The shoulders are no longer symmetrical, the one on the injured side being flattened, its acromion process unnaturally prominent, beneath which the finger readily sinks into the glenoid cavity. Another diagnostic mark presents itself by tracing the outer side of the luxated humerus upwards from the elbow, when it will be found that the upper part of the bone offers no support to the hand, which sinks towards the axilla from the yielding of the soft parts. There is more or less pain attending this accident, depending upon the extent of the displacement and the direction of the head of the bone, from which results the comparative degree of injury to the axillary plexus of nerves. With the presence of all these diagnostic marks, there can be no mistake made as to the nature of the accident; and if the luxation be of recent occurrence, the surgeon may proceed at once to reduce it.

In this accident all those muscles which arise from the upper part of the scapula, and are inserted into the os humeri, must be more or less put upon the stretch as their points of attachment are rendered more distant. The two spinati, the subscapularis, the coraco-brachialis, and teres minor, are therefore extended; more particularly the subscapularis, and not merely from the separation of its two points of attachment but also from the violence inflicted upon it by the head of the os humeri, which not unfrequently causes its laceration. The elbow in this accident being removed from the side, the teres major and posterior fibres of the deltoid muscle are relaxed, while the anterior fibres of the latter muscle are extended. The pectoralis major and latissimus dorsi are but slightly affected, but are still to be kept in view in reference to the direction of the force necessary for the reduction of the bone.

Dislocation Forwards and Inwards upon the Venter of the Scapula.

The head of the humerus in this case is thrown beneath and behind the coracoid process of the scapula on the venter of that bone, covered by the subscapularis muscle. At first, there is but little shortening of the limb; but if the dislocation remains but a few days unreduced, the pectoralis major muscle draws the head of the bone upwards and inwards towards the clavicle, and considerable shortening then occurs. In this situation the head of the bone, may be felt, covered, however, by the pectoralis major, minor, and subscapularis muscles; the elbow is widely separated from the side, and is directed obliquely backwards. The limb has but slight mobility, but most motion backwards, as in that direction muscle forms its only opposing force. The muscles in this dislocation are under much the same circumstances as in the last described, excepting that the subscapularis is partially torn up from its attachment to the venter of the bone. The degree of violence necessary to produce this accident renders the prognosis less favourable than in the common dislocation into the axilla.

Dislocation Backwards and Outwards upon the Dorsum of the Scapula.

Boyer, in speaking of this accident, says, " there is no well-attested instance of dislocation of the humerus on to the dorsum of the scapula." And goes so far as to reason upon circumstances why it should not occur, observing, that the tendon of the long head of the triceps would oppose it ; notwithstanding this authority however, there are numerous instances of its occurrence, and I have, myself, seen several. The diagnostic marks of this injury are, loss of motion of the limb, with a direction of the arm forwards, attended with a slight degree of pronation of the affected extremity, the natural roundness of the shoulder may rather be said to be altered than lost, as the flattening occurs only anterior to the acromion, in which situation the skin is drawn into puckers or folds. On tracing the humerus upwards from the elbow, the eye is carried in a direction behind the glenoid cavity ; and if the patient be thin, the head of the bone may be both seen and felt upon the dorsum of the scapula, where it is resting upon the fossa infra-spinata, between the teres minor and the infra-spinatus muscles. In attenuated persons also, the coracoid process would be unnaturally conspicuous.

Mode of Reduction.

In recent cases of dislocation into the axilla, the surgeon may, without any previous preparation of the patient (unless he be excessively muscular), proceed to the reduction of the bone in the following manner. The patient should be placed in the recumbent posture, either on the floor or upon a sofa, when the surgeon, sitting on the side of the affected limb, places his heel in the axilla, resting it on the head of the bone and taking hold of the patient's wrist, performs simultaneously, extension and counter-extension through the medium of his own muscular power, which, being steadily kept up for a few minutes, the head of the bone is usually felt to move, when the surgeon, by drawing the arm inwards, and with his heel directing the head of the bone outwards, forms, through the medium of the arm, a lever of the first order, and thus generally easily succeeds. Should further power, however, be required as the extending force, a towel may be attached to the affected extremity by means of the clove hitch, and so an additional force may be obtained. If, however, the accident has occurred, for any length of time, before means of reduction are attempted, the patient's muscular power should be first subdued by bleeding and nauseating doses of tartarized antimony; and in some cases, it may be required that the extension should be made by means of pullies, the scapula being first fixed by passing the arm through an opening of a padded leather strap, and attaching it to some sufficiently fixed object.

In the reduction of the dislocation backwards and inwards, Sir Astley Cooper recommends that it should be attempted by raising the limb perpendicularly, and at the same time directing the arm behind the patient's head, the spine of the scapula is thus made a fulcrum, and the head of the bone tilted into its natural situation. I have, however, known the reduction of this dislocation effected by fixing the scapula and making extension from the wrist in the direction of the displaced bone; the heel must not in this case be placed in the axilla, as it would necessarily oppose the return of the head of the bone into the glenoid cavity.

Articulation of the Humerus with the Radius and Ulna.

CLASS *Diarthrosis.*—SUBDIVISION *Ginglimus.*

The elbow-joint is composed of the condyles of the humerus above, and of the heads of the radius and ulna below; the rounded extremities of the former being received in corresponding cavities in the two latter, the surfaces of which are completely covered with cartilage. This union forms a complete hinge-joint; but the radius also enjoys rotatory motion, which produces pronation and supination of the hand: this is effected by the head of the radius receiving but a small rounded portion of the external condyle of the humerus above, while the inner half of the circumference of its head is received into the less sigmoid cavity of the ulna, both these portions being covered with cartilage. This mode of articulation allows the radius to turn upon its own axis.

Four ligaments concur in the formation of the elbow-joint: an *anterior*, a *posterior*, an *external* and an *internal lateral ligament;* all of which are lined by *synovial membrane.*

The *anterior ligament* arises from the lower part of the humerus, between the two condyles immediately above the cavity which receives the coronoid process of the ulna in flexion; it also reaches laterally as far as the edges of the condyles, over which it passes downwards to be inserted into the coronary ligament of the radius, and root of the coronoid process of the ulna: its fibres pass in different directions; those from the internal condyles, with considerable obliquity, to be attached to the coronary ligament of the radius, while the middle and external fibres pass vertically downwards.

The *posterior ligament* arises from the upper part of the cavity of the humerus, which receives the olecranon of the ulna in extension; it passes laterally on the sides of the condyles, where it meets with the anterior ligament, and also with the upper edges of the internal and external lateral ligaments; it passes to be inserted into the sides of the olecranon, and is connected with the lower and posterior part of the os humeri, between the two condyles. This ligament can only be entirely exposed when the fore arm is flexed upon the upper. Its posterior surface is covered by the tendon of the triceps, while its anterior, is in contact with the synovial membrane, which lines both this and the anterior ligament.

External lateral ligament.—This ligament is so intimately connected with the tendons of those muscles which arise from the external condyle of the os humeri, as to be with difficulty separated, and seems to have a common origin with the supinator radii brevis; it is of a triangular shape, its apex being situated above, and its base below. It arises from the lower part of the external condyle, becomes broader as it descends, passes over the articulation, then spreads itself so as to surround the head of the radius; and is inserted into the anterior and posterior edges of the smaller sigmoid cavity of the ulna, in common with the coronary ligament, which it covers. Thus it is clear, that the rotatory motion of the radius is not confined by this ligament, as it is inserted only into the ulna and coronary ligament, and is entirely unconnected with the radius itself.

The *internal lateral ligament*, is of the same shape as the preceding, being triangular; but is more distinctly marked by the direction of its fibres, which pass anteriorly and posteriorly. It arises from the internal condyle; the anterior fibres, passing from it to the coronoid process of the ulna, are covered by the flexors of the wrist and fingers, and are in contact with the synovial membrane; its posterior fibres have the same origin, diverge from the former, and pass backwards to be inserted into the inner side of the olecranon; they also give attachment to the synovial membrane, and protection to the ulnar nerve. The insertions of this ligament are connected by some ligamentous fibres, which are attached to the olecranon and coronoid process, and by some anatomists have been described as a separate ligament.

Synovial Membrane.—To obtain an accurate knowledge of this membrane, the tendinous expansion of the muscles, with the ligaments connecting the joint, and the subjacent fat, must be removed; we shall then find that it takes its origin from the anterior concave surface of the olecranon, passes down to line the whole of the great sigmoid cavity of the ulna, prolongs itself between the radius and ulna, covering the less sigmoid cavity, reaches as far as the neck of the radius, where it becomes reflected, forming a *cul de sac*, and lines the inner surfaces of the coronary ligament; it then extends itself upon the posterior surface of the anterior ligament of the elbow-joint, passes over the two condyles of the os humeri, covers the anterior surface of the posterior ligament, and terminates at the point from which we began the description.

Motions of the Elbow-Joint.

Flexion and extension are the only motions of which the elbow-joint is capable. During flexion, the radius and the ulna slide from behind to before, on the condyles of the humerus, so as to allow, in the most perfect state of flexion, the fore arm to form a very acute angle with the humerus; indeed, it becomes almost parallel with it, which is admitted by the coronoid process of the ulna dipping into the pit on the fore part of the humerus. The anterior surface of the external condyle is covered with articular cartilage, that the radius may enjoy the same extent of flexion as the ulna.

During extension, the radius and the ulna move from before backwards on the condyles of the humerus, and the full extent of this motion is completed, when the arm is brought to nearly a straight line; for extension cannot be carried beyond this, in consequence of the olecranon striking against the back part of the humerus. In the performance of this motion, the radius is separated from the external condyle of the humerus; so that in the perfect state of extension, these two bones are not in contact, but the radius is pressed firmly into the less sigmoid cavity of the ulna; and its rotatory motion in this state is rendered much less perfect, in consequence of its having lost its support from the humerus.

Practical Remarks.

The radius and the ulna may be dislocated from the humerus either *backwards* or *laterally*, forwards they cannot be thrown without fracture of the olecranon; so that luxation, in that direction, is to be considered as a secondary accident.

In the dislocation of both bones *backwards*, the radius and ulna are thrown upward behind the condyles of the humerus, and the coronoid process of the ulna occupies the fossa, situated at the posterior part of the humerus, while the radius rests above the external condyle. The capsular ligament is torn through anteriorly; the internal lateral ligament is relaxed, and the external lateral is liable to have its anterior fibres lacerated. The coronary ligament suffers no change but in position, being drawn with the dislocated bones upwards and backwards. The biceps is considerably extended, but not to the same degree as the brachialis internus, in consequence of the more elevated situation of the coronoid process of the ulna, into which this muscle is inserted. The triceps muscle is relaxed, from the approximation of its points of attachment; and the anconeus, although it must necessarily be relaxed, is in danger of having some of its fibres lacerated by the forcible projection of the head of the radius above the external condyle, from which this muscle has origin. All muscles which arise from the condyles of the os humeri are necessarily relaxed, excepting the supinator radii brevis, which has some of its fibres torn through. The fore arm, in this accident, maintains a semiflexed position; and no force less than that which is capable of reducing the dislocated bones will produce extension. The best diagnostic mark of this accident is the change of position of the olecranon, which is found thrown up above the external condyle, instead of being, as is the natural position, upon a level with it; a considerable hollow is also perceived on each side the olecranon, and anteriorly, a hard tumour may be felt in the natural situation of the hollow of the elbow, produced by the projection of the condyles of the humerus.

The dislocation of both bones *laterally*, can take place either to the inner or outer side; but in consequence of the great extent, and irregularity of the articular surfaces, it is rarely complete: this luxation seldom occurs in comparison with the last mentioned accident. The state of the muscles, and of the capsular ligament, are under the same circumstances as in the dislocation backwards, with this unimportant difference, that the muscular fibres have an obliquity either outwards or inwards, depending on the direction of the dislocated bones.

The dislocations of the head of the radius, which are generally enumerated amongst the accidents of the elbow-joint, may be more properly considered as injuries incident to the superior radio ulnar articulation.

Radio Ulnar Articulations.

The radius and the ulna are connected in their whole course by ligaments; which, according to their relative situations, may be divided into those of the *superior, middle,* and *inferior articulations.*

The Superior Radio Ulnar Articulation.

CLASS *Diarthrosis*—SUBDIVISION *Trochoides.*

The upper extremity of the ulna is furnished with a depression, which is named the less sigmoid cavity, for the purpose of receiving the head of the radius. Both the cartilage and synovial membrane which enter into the composition of this joint, are continuous with that of the elbow. This articulation forms a lateral hinge, admitting of the supination and pronation of the hand, but is not affected with the motion of flexion and extension of the fore arm. There is but one ligament connecting this joint,

The *coronary ligament;* composed of strong and thick fasciculi, which arise from the posterior edge of the less sigmoid cavity of the ulna; it then passes around the neck of the radius, and is inserted into the anterior edge of the same cavity, thus forming three-fourths of a circle, from which disposition it gains its name. This ligament passes in such close contact with the radius as to prevent any separation, but is not adherent to it, and therefore allows of the free rotatory motion of that bone: it is fibrous in its texture, the fibres pass in a circular direction, and are more obvious at its extremities than in its centre. The external surface of this ligament is covered by the muscles arising from the outer condyle of the humerus, and by the external lateral ligament: its internal surface is lined by the synovial membrane; which, as has been before said, is continued from the elbow-joint. Its superior circumference is connected with most of the ligaments of this articulation, while its inferior circumference is free.

Middle Radio Ulnar Articulation.

The connexion of the radius and ulna cannot, strictly speaking, be termed an articulation, as the bones are not found in actual apposition. There are two ligaments which serve to connect the radius and ulna nearly their whole length; they differ in their figure and in their use; the upper one is a mere cord, which extends transversely from one bone to the other, and assists in preventing their forcible separation; the other is a broad ligament, which fills up the space produced by the natural separation of the radius from the ulna; and not only connects these bones, but also gives origin to many muscles, and thus becomes included within the class of ligaments which perform the office of bone.

The *first*, or *oblique ligament*, is composed of thin fibrous fasciculi, which are rounded in their form, and originate on the outer side of the coronoid process of the ulna, just below the insertion of the brachialis internus muscle; it then takes an oblique direction downwards and outwards, passes across from one bone to the other, and is inserted into the tubercle of the radius, immediately below the insertion of the biceps; and as it crosses from its origin to its insertion, it leaves an opening between it and the interosseous ligament, through which pass vessels and nerves. This ligament separates the superficial from the deep set of muscles of the fore arm, and is on a plane anterior to the interosseous ligament.

The *interosseous ligament* begins to arise immediately below the tubercle of the radius, and passes from the inner sharp edge of the radius, to the outer edge of the ulna. It is not one uninterrupted extension of ligament, but consists of a great many flattened fasciculi, which are separated from each other, leaving openings for the transmission of vessels and nerves: it extends as far inferiorly as to the connexion of the radius with the ulna. Its two lateral edges are firmly connected with the periosteum of the two bones to which they are attached. Its anterior face above gives attachment to the deep flexor muscle of the fingers, and to the proper flexor of the thumb: its lower fourth is covered by the pronator quadratus muscle. On the posterior surface of this ligament may be seen some fibres, which pass from the ulna to the radius, and which, consequently, cross the usual direction of the fibrous texture of the interosseous ligament, thus tending very much to add to its strength. This ligament is covered posteriorly by the supinator radii brevis, and extensor muscles of the fingers and wrist. There has been already mentioned one opening above, which is between the interosseous and the oblique ligaments, and which allows the passage of the interosseal vessels; but below there is another, of an oval form, just above the pronator quadratus muscle, extending through the ligament itself, and giving exit to the anterior interosseous vessels.

The *use* of the interosseous ligament appears to be rather for the attachment of muscle than for the firm connection of the radius and ulna, which are so strongly bound together at each extremity, as scarcely, in that respect, to need its support; it does, however, assist in preventing the radius from being dislocated from the ulna.

Inferior Radio Ulnar Articulation.

At the inferior extremity, the radius receives the ulna in a concave articular surface, which is covered with cartilage and synovial membrane, the two bones being retained in their situation by some anterior and posterior ligamentous fibres, which pass transversely from one bone to the other, and strengthen the synovial capsule. There is also an inter-articular fibro cartilage, extending from the inner edge of the radius, and insinuates itself between the ulna and the bones of the carpus, which assists in completing this articulation.

The *inter-articular cartilage* is a production from the cartilaginous surface of the scaphoid cavity of the radius, proceeds from it obliquely inwards, and is placed transversely between the inferior extremity of the ulna, and the cuneiform bone; thus preventing the extremity of the ulna from coming in contact with the bones of the carpus, and dividing the synovial cavity of the wrist, from that of the inferior radio ulnar articulation.

The external edge of this cartilage is connected with the lower and inner edge of the radius, while its internal edge is free, with relation to bone, being only attached to the styloid process of the ulna through the medium of the internal lateral ligament of the wrist-joint. Its superior surface is opposed to the inferior extremity of the ulna: its inferior surface is in the same place with the scaphoid cavity of the radius, and opposed to the cuneiform bone of the first range of the carpus. During the motions of pronation and supination of the hand, the inter-articular cartilage is pressed against the styloid process of the ulna, and thus forms the fixed point for the motions of the radius.

Synovial membrane.—This membrane is situated between, and reflected over, the surfaces of the outer and lower extremity of the ulna, the superior surface of the inter-articular cartilage, and the small articular cavity on the radius which receives the ulna. On a more accurate examination we may trace it, first covering the outer surface of the styloid process of the ulna, from thence it descends upon the superior surface of the inter-articular cartilage, passes upon it outwards to the point where this cartilage is connected with the radius, then is continued upon the cavity of the radius which receives the ulna, passes over to that bone, forming a *cul de sac*, or sacciform ligament (as it is called), between the two, then descending along the articular surface of the ulna, terminates at the place from whence I commenced the description; this synovial cavity being entirely separated from that between the radius and the bones of the carpus by the inter-articular cartilage.

Motions of the Radio Ulnar Articulations.

These motions produce pronation and supination of the hand, which are effected by the radius turning inwards or outwards on the ulna, and carrying the hand along with it. In pronation, the head of the radius turns upon the ulna in a direction from without to within, rolling within the annular ligament; while its inferior extremity turns also from without to within upon the ulna; describing in this motion a considerable portion of a circle; so that the relative position of the two bones becomes somewhat altered, by the radius obliquely crossing the ulna:—in this motion the palm of the hand faces backwards. Supination is produced by reversing the former motion, by bringing the two bones again parallel, and by directing the palm of the hand forwards.

Practical Remarks.

The head of the radius may be dislocated from the less sigmoid cavity of the ulna, so as to be thrown either upon its fore or back part, which accidents, as I have before mentioned, are usually described as incident to the elbow-joint, but more properly belong to the superior radio-ulnar articulation.

On examining the form of the articulatory surfaces of this joint, we should be led to suppose that the dislocation *forwards* happened more frequently than that *backwards;* but the reverse is found to be the case: for as these accidents occur from violent and inordinate force in the motions of pronation and supination, the former being so much more extensive than the latter, tends to throw the head of the radius behind the ulna; while the comparatively less extensive motion of supination, rarely produces a luxation forwards.

When the radius is dislocated *backwards*, the nature of the accident may be learnt by feeling on the outer side of the fore arm, an inch below the external condyle, when a depression is felt instead of the natural projection produced by the head of the bone, which is found placed on the back part of the olecranon. The hand is in this accident proned, and cannot be brought to its natural state. The mode of reduction is obvious from the position of the injured limb, viz., that the fixed position of pronation is to be overcome; which may be effected by semiflexing the fore arm, for the purpose of relaxing the biceps muscle; by producing a forcible motion of supination, and at the same time pushing the head of the radius forwards and inwards, towards the smaller sigmoid cavity of the ulna: the natural position of the two bones is thus usually readily restored; unless, indeed, the dislocation has been allowed to remain unreduced for a considerable time.

In the displacement *forwards*, which is an accident of very rare occurrence, the great distinction is the fixed, supined position of the arm; and the tumour formed by the head of the radius, being on the fore, instead of the back part of the ulna, as in the last described injury. The means to be employed for the reduction are, to prone the hand, and to push the head of the radius backwards. The after-treatment of these accidents consists in applying compresses with rollers, so adjusted as to press particularly on the head of the radius, and to prevent the recurrence of displacement, which is liable to happen, in consequence of the coronary ligament being torn through; neither should any motion be allowed for some time, as the ligaments are slow in their reparative powers.

The ulna is also sometimes luxated from the inferior extremity of the radius; for although the radius moves upon the ulna at the inferior radio ulnar articulation, still it is to be considered as the extremity of the ulna, which escapes from the lesser scaphoid cavity of the radius, rather than a displacement of the radius itself. The inferior extremity of the ulna may be dislocated either forwards or backwards from the radius; the displacement backwards is most frequent, as it is produced by an extensive pronation of the hand—a motion much more frequently exerted than supination, which has a tendency to produce the dislocation forwards.

Radio Carpal Articulation; or, Wrist-Joint.

CLASS *Diarthrosis.*—SUBDIVISION *Arthrodia.*

This joint is produced by the junction of the hand and the fore arm. The convex surfaces of the os scaphoides and the lunare, are received into the cavity formed at the inferior extremity of the radius; while the cuneiform bone is opposed to the under surface of the inter-articular cartilage, which cartilage has already been described as assisting in the formation of the inferior radio-ulnar articulation; all these surfaces are covered by a synovial membrane. This joint is further strengthened by the four following ligaments.

The *anterior ligament* is flat, and delicate in its texture; it arises from the fore part of the inferior extremity of the radius, passes downwards and forwards to be inserted into the scaphoid, lunar, and cuneiform bones; it is covered by the tendons of the flexors of the fingers, and posteriorly it is lined by the synovial membrane.

The *posterior ligament* arises from the lower and back part of the radius, and passes to be inserted into the lunar and cuneiform bones; this ligament is not so strong as the anterior; it is covered by the extensor tendons of the fingers, and is opposed to the synovial membrane.

The *external lateral ligament* arises from the lower extremity, or apex of the styloid process of the radius; descends to the bones of the carpus, is inserted into the outer side of the scaphoid bone, and from thence is continued to the trapezium: it is of a triangular form, the apex being attached to the radius, while the base is composed of diverging fibres, which pass before and behind, and are connected with the anterior and posterior ligaments, which have been just described.

The *internal lateral ligament* arises from the inner surface of the styloid process of the ulna, and passes downwards to be inserted into the cuneiform bone, from which it sends off a strip anteriorly to be connected with the os pisiforme. As this ligament passes from the ulna to the carpus, it becomes attached to the inter-articular cartilage, which divides the ligament into an upper and a lower half; the upper portion is covered by the synovial membrane of the inferior radio-ulnar articulation, and the lower by the synovial membrane of the radio-carpal articulation. Both these last described ligaments are very strong, and prevent the displacement of the bones, which might otherwise have been of frequent occurrence, from the extent of motion to which they are liable.

Synovial membrane.—This membrane covers the scaphoid cavity at the lower extremity of the radius, and the under surface of the inter-articular cartilage; passes anteriorly from these points of attachment to the inner surface of the anterior ligament of the wrist-joint, and to the lower half of the internal lateral ligament; then passes upon the superior surfaces of the scaphoid, lunar, and cuneiform bones, dipping in between each to line their connecting faces, and forming a synovial cavity between them; ascends upon the posterior ligament, passes sufficiently far outwards to give a lining to the external lateral ligament, and terminates at the point from whence this description began.

From these particulars it is clear that there are two joints at the wrist; the one is named the inferior radio ulnar articulation, which does not form a joint with the bones of the carpus, but allows the radius to roll upon the ulna, and performs the motions of pronation and supination of the hand, while the radio carpal articulation admits of the motions of flexion and extension, and forms a joint with the three outer bones of the first carpal row;—not that the cuneiform bone is in contact with the radius, but that it is still connected with it by the same synovial membrane which is common to the other two bones of the carpus.

Previous to describing the ligaments proper to the bones of the carpus, I shall give an account of such as tie down the tendons of those muscles serving for the motions of the hand and fingers, which are found on the dorsal and palmar regions of the wrist, commencing with the palmar region.

Ligamentum carpi annulare.—This ligament, which is extremely strong, passes anteriorly across the concave arch of the carpus, for the purpose of tying down the tendons of the flexor muscles of the fingers, and also assists in preventing displacement of the carpal bones under any violent application of force. It arises from the pisiform, and from the hook-like process of the unciform bone, passes transversely across the carpus, and is attached to the scaphoid and trapezium. Its posterior surface is in contact with the flexor tendons of the fingers, and the anterior is covered by the aponeurotic expansion of the palmaris longus, and by the muscular fibres of the palmaris brevis, by the ulna artery, and by the superficial volar branch from the radial. The ulna artery, however, as it runs over the ligament, is protected by a process of it which passes from the pisiform bone, or rather from the insertion of the flexor carpi ulnaris, outwards to the middle of the superior edge of the annular ligament, and thus forms a groove for its safe transmission.

Ligamentum carpi annulare dorsale.—This ligament is situated on the posterior part of the wrist; performing the same office, in tying down the extensor tendons of the hand and fingers, which the preceding ligament performs for the flexors. It arises from the styloid process of the radius, passes in an oblique direction from without to within, to be attached to the styloid process of the ulna; and in its passage along the posterior surface of these bones, it is connected with the edges of the grooves, which allow the passage of the extensor tendons, and thus forms sheaths for their protection and transmission. Its posterior surface is only covered by skin and cellular membrane; while, anteriorly, it is in contact with the tendons, and a membrane which secretes a fluid to lubricate them, and prevent friction on their various motions. Its inferior edge sends off an aponeurotic expansion, which passes over the back of the hand, and assists in maintaining the extensor tendons in their passage to the fingers.

Motions of the Wrist-Joint.

The hand moves on the fore arm, so as to allow of flexion, extension, abduction, adduction, and slight circular motion. With respect to the motions of flexion and extension, this joint differs from all others, in allowing extension to the same extent as flexion; indeed, it is the direction in which the hand is most frequently employed. The slightest circular motion of the hand upon the radius, assists in the perfect performance of the movements of pronation and supination.

Articulation of the Bones of the Carpus with each other.

CLASS *Diarthrosis.*—SUBDIVISION *Arthrodia.*

I have already mentioned, that the first, or cubital row of the carpus, receives its synovial membrane, for its junction with the radius, from a prolongation of the membrane of the radio carpal articulation; but this joint is further strengthened by other ligaments, which connect the bones of this row firmly together, and are situated between these bones on their anterior and on their posterior surfaces.

Interosseous ligaments.—These are short but very strong ligaments, which connect the scaphoid, the lunar, and the cuneiform bones: they are composed of dense fibres, which are laterally united firmly to each bone; their superior face is covered with the synovial membrane of the radio-carpal articulation, to which they are attached.

The *anterior* or *palmar ligament* is found situated immediately under the anterior ligament of the wrist-joint, takes an oblique direction from without to within, being connected to the scaphoid, lunar, and cuneiform bones; and as it passes from one of these bones to the other, it becomes connected with the interosseal ligaments.

The *posterior* or *dorsal ligament* has attachment to the same bones as the palmar ligament; its posterior surface is in contact with the posterior ligament of the wrist-joint, and its anterior with the interosseous ligaments; it also tends to strengthen this row of the carpus.

Articulation of the Pisiform Bone.

This bone being situated anteriorly to the other bones of the carpus, has a peculiar articulation with the os cuneiforme, which is furnished with a synovial membrane covering the articulatory surface of each bone; it has also an inferior ligament, which connects it with the hamillary process of the unciform bone, and is further strengthened and maintained in its situation by the insertion of the flexor carpi ulnaris.

The Second or Digital Row of the Carpus.

The bones of this row are connected by interosseous, palmar, and dorsal ligaments, precisely similar to the cubital row; the fibres of which pass from without to within, in a transverse direction, from the trapezium to the unciforme, and are attached to the intermediate bones.

Articulation of the Two Rows of the Carpus with each other.

This articulation consists of three distinct joints, viz., the trapezium and trapezoides with the scaphoid; the unciform with the cuneiform; and the os magnum with the lunar and scaphoid bones: the two first forming an arthrodial articulation, while the latter forms an enarthrodial joint. These joints are connected by external and internal lateral, anterior and posterior ligaments, and by synovial membrane.

The *lateral ligaments* appear to be nothing more than a continuation of the external and internal lateral ligaments of the radio carpal articulation; being attached, as they descend on the outer side, to the scaphoid and the trapezium; and on the inner, to the cuneiform and unciform bones.

The *anterior* and *posterior ligaments* are formed of short, strong, fibrous fasciculi, which pass in various directions from the cubital to the digital row. They are situated immediately underneath the ligaments of the radio carpal articulation, with which they form a strong fibrous covering to the whole of the carpus.

The *synovial membrane* not only covers the articulatory surfaces by which the bones of the two rows of the carpus are connected with each other, but also insinuates itself between the bones of each row, so as to form a synovial cavity, prolonging itself both superiorly and inferiorly upon the articulatory surfaces of every bone, excepting the pisiform.

Articulation of the Carpus with the Metacarpus.

Articulation of the First Phalanx of the Thumb with the Os Trapezium.

Class *Diarthrosis.*—Subdivision *Arthrodia.*

This joint is connected by a strong *capsular ligament,* which is formed of longitudinal fibres, passing from the neck of the first phalanx of the thumb to the edge of the articulatory surface on the trapezium; it is loose, and has its internal surface lined by synovial membrane, while its external surface is strengthened by the muscles of the thumb.

Articulation of the four Metacarpal Bones with the Carpus.

The four bones of the metacarpus are connected with the carpal bones by *synovial membrane,* which is a continuation of that of the carpus, and by *dorsal* and *palmar ligaments,* proceeding from the inferior extremity of the digital row, to be attached to the necks of the metacarpus. Each of the metacarpal bones is furnished with as many fasciculi of palmar and dorsal ligaments, as it has attachments to bones of the carpus; for instance, the metacarpal bone of the fore finger has a fasciculus from the trapezium, trapezoides and os magnum.

Articulation of the Bones of the Metacarpus with each other

The first phalanx of the thumb is not connected with any of the metacarpal bones. But they are themselves in actual contact posteriorly, and are furnished with small synovial capsules; these articulations are strengthened by *dorsal* and *palmar* ligaments, which pass transversely from one bone to the other, forming rather one continuous surface than being separable into three distinct fasciculi, as generally described.

The inferior extremities of these bones diverge, but are connected by *transverse ligaments*, which are divided into two sets of fibres, a *superficial*, and a *deep:* the *latter* are the shorter, and exclusively deserve the name of intertransverse, passing from one bone to the other: their anterior faces are crossed by four depressions, which answer to the passage of the tendons of the flexor muscles of the fingers, and the lumbricales. Posteriorly, they are connected with the tendons of the interosseous muscles, and with the ligaments connecting the phalanges with the metacarpus. The *superficial* fibres pass across all the metacarpal bones, both on the *dorsal* and *palma regions*, but is not connected with the first phalanx of the thumb.

Articulation of the Metacarpus with the Phalanges.

Class *Diarthosis.*—Subdivision *Arthrodia.*

The rounded inferior extremity of the metacarpus, is admitted into the cavity of the superior extremity of the first phalanx of the five fingers, and their joints are connected by anterior and lateral fibres which form capsular ligaments, and by a lining synovial membrane.

The *anterior ligament* is a half annular ligament, attached to the fore parts and sides of each metacarpal bone, immediately below their intertransverse ligaments, from whence it passes to be inserted into the superior extremity of each phalanx. It is in the thick part of this ligament that the sesamoid bones of the thumb are placed, between which its proper flexor muscle passes.

The *lateral ligaments* proceed from the sides of the inferior extremity of the metacarpal bones, as far as to the sides of the superior part of the phalanges. These ligaments are connected with the sheaths which protect the tendons of the flexor muscles, and their edges are in contact with the vessels and nerves of the fingers.

The *synovial membrane* covers the cartilaginous surface of the bones of the metacarpus, passes behind the anterior ligament and within the lateral, and surrounds the articular surface of the phalanx; it then forms a loose capsule under the tendon of the extensor muscle.

Articulation of the Phalanges.

CLASS *Diarthrosis.*—SUBDIVISION *Ginglimus.*

The articulation of these bones with one another form a perfect hinge-joint; they have each a synovial capsule, an anterior, and two lateral ligaments, which, in situation and attachment, resemble so precisely those of the articulation of the phalanges with the metacarpus, as to render their description unnecessary.

Motions of the Carpus.

The two rows of the carpus which have already been described, as forming in part an arthrodial and in part an enarthrodial articulation, admit of some slight degree of motion upon each other; but yet this motion is rather to be considered as general, with respect to the whole hand, than in particular with the bones themselves. The direction in which their motion is permitted is extension and flexion; the former taking place to a greater extent than the latter. There is also some slight degree of motion between each of the bones of the carpus, but so limited that it is rather to be considered for the purpose of preventing injury to the hand from concussion, than to assist in the functions of the hand itself.

Motions of the Metacarpus upon the Carpus.

The four metacarpal bones admit of some slight degree of motion from before to behind. This cannot be described as flexion and extension, but allowing only their surfaces to slide, and not to turn upon the articulatory faces of the carpus. With this motion, that of the bones of the metacarpus on each other may be included, which must necessarily admit of some sliding on themselves, to allow of their motion on the carpus.

Motions of the Phalanges on the Metacarpus.

In this description I include the motions of the thumb upon the carpus, having already stated the reasons for considering the thumb to be composed of three phalanges. The first phalanges of the four finger execute a motion of flexion, extension, abduction, adduction, and circumduction, upon the metacarpus; while that of the thumb moves upon the os trapezium of the digital row of the carpus, and enjoys a much more extensive motion than the others. The articulations between the first and second, and second and third phalanges of all the fingers, form complete hinge-joints, and admit therefore only the flexion and extension, the former, to a much greater extent than the latter. If we consider the combined motions of all the bones of the hand, we shall be better able to appreciate how admirably it is adapted for the facility, with which it is able to perform the various motions necessary for its peculiar uses.

Practical Remarks.

Dislocations to which the Wrist-Joint is liable.

It sometimes happens, that the convex surfaces of the three first bones of the carpus are separated from the concave surfaces of the radius and inter-articular cartilage: and it is possible for the carpus to be thrown either backwards, forwards, externally or internally; but, from the formation of the wrist-joint, the dislocation backwards is the most frequent, the convex articular surfaces of the three first bones of the carpus sloping in that direction.

Dislocation backwards.—This accident usually occurs from a fall upon the back of the hand while the hand is flexed; the force being then applied to the inferior extremities of the metacarpal bones, the carpus is tilted over the posterior surface of the radius, and a deformity immediately produced; which, with the consequent shortening and permanent flexion of the hand, render the nature of the accident at once sufficiently apparent. The posterior ligament of the wrist is necessarily torn through, and the lateral ligaments may have some of their anterior fibres ruptured.

Dislocation forwards.—This accident, which but rarely occurs, may be produced by a fall on the palm of the hand during extension, and the carpus is driven before the radius: the hand is painfully extended and shortened, and the deformity considerable, but not so obvious as in the last described accident, particularly as the dislocation is scarcely ever complete, and the cavity of the hand renders its detection more difficult. In this dislocation the anterior ligament is torn through, and the lateral ligament is placed under the same circumstances as in the last described accident.

In the *lateral dislocations*, the displacement can never be complete; but a projection of the carpus on the inner or outer side, is a sufficient diagnostic mark of the nature of the injury. The degree of laceration of the anterior, posterior and lateral ligaments, is in proportion to the extent of displacement. In any of the dislocations of the wrist-joint, if the case be recent, reduction is easily accomplished by slight extension of the hand; therefore, no time should be lost in reducing the bones to their natural situation, not allowing time for a fixed contraction of the muscles.

Dislocations of the carpus.—From what has already been said of the motions and general functions of these bones, their displacement from each other, without fracture, may be considered as almost impossible, although some authors have described cases in which the os magnum has been thrown from the cavity formed for it, by the lunar and scaphoid bones upon the back of the hand, there forming a considerable tumour. The means to be employed for its reduction are sufficiently obvious: force should be applied upon the dorsal surface of the dislocated bone, while the hand is kept in an extended position; and if these means are early employed, its replacement may be effected without much difficulty.

Dislocations of the metacarpus.—From the description which has been given of the formation of the articulations and motions of the metacarpal bones on the carpus, and of their connexion with each other, their dislocations must necessarily be of very rare occurrence; for a force sufficient for their displacement, would rather fracture the bones than produce their luxation, unless previous disease had destroyed the natural means of their connexion.

Dislocations of the phalanges.—The first phalanges present a concave surface, to receive the convex extremities of the metacarpal bones; and in consequence of the rounded surfaces of these bones extending much further forwards than backwards, the first phalanx can scarcely be thrown into the palm of the hand, but is forced backwards on the metacarpal bones. This accident most frequently occurs to the thumb, and may be readily known by the deformity on the metacarpus, and by the extension of the first phalanx, while the second is bent. The other phalanges are also liable to similar dislocations, which are not easily reduced, particularly if any length of time has elapsed between the accident and the attempt at reduction; for in consequence of the smallness and shortness of the dislocated phalanx, it becomes very difficult to apply, by any mechanical means, a sufficient force to restore the bone to its natural situation; which, however, may be effected by the application of a piece of tape, fixed to the extremity of the dislocated phalanx in the form of a "clove hitch."

LECTURE X.

ARICULATIONS OF THE PELVIS AND LOWER EXTREMITIES.

Articulations of the Pelvis.

The ligaments which serve to strengthen those articulations may be divided into two sets; those which attach the pelvis to the vertebræ, and those which connect the different bones of the pelvis with each other. There are but two of the first order which differ, in any respect, from the ligaments common to the vertebræ; for the superior surface of the sacrum is found connected with the last lumbar vertebra by an inter-vertebral substance; a continuation of the common anterior and posterior ligaments of the vertebræ also strengthens this connexion; capsular ligaments are found attaching the articular processes, of the sacrum to the last lumbar vertebra; and, lastly, similar inter-spinous ligaments, and a continuation of the ligamentum subflavum, serve to connect them. There are, however, two others which require a particular description.

First, the *sacro lumbar ligament*, which arises from the inferior and anterior part of the transverse process of the last lumbar vertebra, and passes downwards and outwards, to be inserted into the superior part of the sacrum. This ligament is of a triangular form, its apex being above, where it is connected with the ilio lumbar, and its base being below; its fibres are intermixed with those of the ilio sacral ligament. Its anterior surface is covered by the psoas magnus muscle, while it covers posteriorly the fibres of the ilio lumbar ligaments.

Secondly, the *ilio lumbar ligament* arises from the transverse process of the last lumbar vertebra, and passes outwards to be attached to the posterior and superior spinous process of the ilium, extending as far downwards anteriorly, as to be mixed with the fibres of the sacro iliac ligaments; in this situation the ligament is divided into two sets of fibres, which gain the distinction of *superior* and *inferior transverse ligaments* of the pelvis. Above, this ligament is covered by the quadratus lumborum muscle; anteriorly, by the psoas magnus; and, posteriorly, it partially gives origin to the lumbar mass of muscle.

Articulations of the Bones of the Pelvis with one another. Articulation of the Sacrum and the Os Coccygis.

CLASS *Diarthrosis*.—SUBDIVISION *Amphiarthrosis.*

This union is completed in the same manner with that which is common to the vertebræ; for the apex of the sacrum, and the base of the os coccygis, have corresponding oval surfaces, connected by a fibrous cartilaginous tissue, similar to the intervertebral substance, but not quite so thick; a continuation of the common anterior and posterior ligaments of the vertebræ, serve to strengthen this articulation, so that a further description of these ligaments is unnecessary.

Connexion of the Sacrum with the Ossa Innominata; or, Sacro Iliac Articulation.

This union, termed the sacro iliac synchondrosis, is formed by the junction of the sacrum and ilium, through the medium of an intervening cartilage.

The following ligaments serve to render this articulation firm.

The *sacro iliac ligaments* connect the sacrum and ilium, both anteriorly and posteriorly; they pass from the two upper bones of the sacrum to the sides of the ilium, and thus envelope the intervening fibro-cartilaginous tissue; the anterior sacro iliac ligament is covered by the psoas magnus, and the posterior by the gluteus maximus muscle. There are, however, several other irregular ligamentous fibres connecting the ossa innominata with the sacrum; but their course is so indistinct and uncertain, as to render it unavailing and useless to attempt their description.

The *posterior sacro sciatic ligament* arises from the posterior and inferior spinous process of the ilium, from the sides of the sacrum, and from the first bone of the os coccygis; then on either side passes outwards and downwards, to be inserted into the tuberosity of the ischium, being there connected with the tendinous origin of the flexors of the leg. Upon the inner side of this portion of bone it extends itself into a ligamentous expansion, from the shape of which it has gained the name of the *falciform ligament,* which runs up on the ascending ramus of the ischium, and forms a canal for the passage of the pudic artery, and also gives origin to the obturator internus muscle. From the posterior surface of this ligament arises the gluteus maximus muscle; its anterior face is partly connected with the anterior sacro sciatic ligaments, but leaving a triangular space between them, which gives passage to the obturator internus muscle, and to the pudic vessels and nerves.

The *anterior sacro sciatic ligament* is the smaller ligament of the two, but of the same form as the last described, before which it is situated. It arises, in common with the posterior ligament, from the ilium, sacrum, and os coccygis, being composed of the most anterior fibres; it passes forwards and inwards, to be inserted into the spinous process of the ischium; its posterior surface is directed toward the posterior sacro sciatic ligament; its anterior, gives origin to the coccygeus muscle. These two ligaments divide the great sciatic notch into two openings; through the upper, which is the larger, passes the pyriformis muscle, the gluteal, and sciatic vessels and nerves; and through the inferior, the obturator internus muscles, with the pudic vessels and nerves. These ligaments exist not only for the purpose of connecting the bones of the pelvis, and diminishing the size of its openings, but also of sustaining its viscera.

Articulation of the Pubes.

The pubes are connected, by the junction of their symphyses with an intervening fibro-cartilaginous substance, which is more thick anteriorly than posteriorly; and their union is rendered firmer by anterior and posterior ligaments, which pass transversely from the one bone to the other.

The *anterior ligament* is composed of transverse ligamentous fibres, which pass from one bone to the other, anterior to the intervening cartilage; it is connected with the periosteum of the pubes, and the aponeurotic expansion from the abdominal muscle.

The *posterior ligament* is stronger than the preceding; it is triangular, and is attached to the superior part of the arch of the pubes, passing some way down on the sides of the descending rami of this bone, and forming a slight curve, the concavity of which faces downwards. It produces the triangular ligament of the pubes; and, from its inferior edge, a strong fascia is given off, which separates the perinæum from the contents of the pelvis; admitting, however, the urethra to pass through it.

The *obturator ligament* comes particularly under consideration, as one of that class which is destined entirely for the purpose of presenting an extension of surface for the origin of muscle, and not for the usual office of binding bones together. It arises from the whole circumference of the obturator foramen, closing it every where, excepting at its upper part, where it leaves a small opening for the passage of the obturator vessels and nerves; its fibres take an irregular course, frequently intersecting one another. Its anterior surface gives attachment to the obturator externus; and its posterior to the obturator internus, and part of the levator ani muscles

Motions of the Pelvis.

The motions of the pelvis may be considered as twofold. First, as a whole, upon the vertebral column, and on the ossa femoris; and, secondly, with regard to the motions between the separate bones entering into its composition; but it is only to the latter that I shall call the attention of my readers at present. The degree of motion between any two of the bones entering into the formation of the pelvis is but very slight in the natural state; unless, indeed, we except the articulation between the sacrum and the os coccygis, which does allow of motion backwards and forwards. But this articulation still comes under the fair denomination of an immoveable joint, in contradistinction to those, which, being under the influence of the will, are moved, consequently, by the action of voluntary muscles, while this joint cannot be acted upon except by some compression, such as the expulsion of the fœtus, which pushes this bone backwards, or pressure from without, which gives it the contrary direction. The sacro iliac symphysis, and the junction of the pubes, will also sometimes admit of a slight degree of motion between them, from continued pressure during protracted parturition.

Practical Remarks.

Under any circumstance, however, the bones of the pelvis are so firmly connected as to preclude the possibity of dislocation, unless, indeed, such be the result of disease and subsequent ulceration. When these bones are exposed to the greatest external violence, we find them rather fractured than separated from each other at their articulatory surfaces. Should such an accident, however, by any possible degree of violence occur, the same means would be employed as in fracture of these bones,—the application of a broad bandage, so as to keep the parts in their relative position; and at the same time passing a catheter into the bladder, to ascertain whether or not injury be done to the urethra, with strict attention to the antiphlogistic treatment, form the best mode of managing these injuries.

Articulations of the Lower Extremities.

Articulation of the Femur with the Bones of the Pelvis.

CLASS *Diarthrosis.*—SUBDIVISION *Enarthrodia.*

The *ilio femoral articulation* is produced by the union of the head of the femur with the cotyloid cavity of the os innominatum; but this cavity is not, with respect to the os innominatum only, of sufficient depth to receive the whole of the head of the femur; for, in a recent state, we find it much more capacious than in a dried bone, from the addition of a fibro-cartilaginous substance investing its circumference; by the assistance of which, it so completely surrounds the head of the femur, as to allow of the motions of the hip-joint, without permitting the separation of one bone from the other—an effect which takes place in the various motions of the shoulder. The surfaces of both the ball and socket of this joint are every where covered with cartilage, excepting the points of attachment of the ligamentum teres. The following ligaments serve to strengthen this articulation: the *capsular*, the *inter-articular* (*or ligamentum teres*), and the *cotyloid ligament*, all of which are covered by synovial membrane.

Capsular ligament.—This ligament, which is the strongest and thickest in the body, surrounds the whole of the joint. It arises from the circumference of the acetabulum, and proceeds in a direction outwards and backwards, to be attached to the base of the neck of the femur, extending outwards to the pit of the trochanter major, and downwards to the trochanter minor; in the intermediate space it is connected with the linea quadrata. It is much less loose than the capsular ligament of the shoulder-joint, being formed equally for strength as for variety of motion, but, in other respects, it is analogous to it. Its thickness is very considerable, particularly before and above, where it is strengthened by an accessory ligament, which passes from the anterior and inferior spine of the ilium, to the fore part of the capsular ligament, with which it is firmly united. On the inner side, the fibres of the capsular ligament are often so much separated as to leave a space between them, exposing the synovial membrane; and again becomes strengthened by fibres, which pass from the obturator foramen. The whole external face of the capsular ligament of this joint is covered by the insertion of muscles destined for the motion of the thigh-bone: its internal surface is lined by synovial membrane.

The *inter-articular ligament*, or *ligamentum teres*, is composed of ligamentous fibres, which pass from the inner and fore part of the cotyloid cavity to a rough fossa on the head of the femur. Its form is triangular, the apex is attached to the thigh-bone, and its base, which is bifurcated, forms two flattened bands, which pass around the circumference of the foramen produced by the cotyloid ligament passing over the notch of the acetabulum. The superior band is of less extent than the inferior, but both are attached to the cotyloid ligament.

Cotyloid ligament.—The circumference of the cotyloid cavity is surrounded by the fibro-cartilaginous substance, which renders it perfectly regular, and forms into a foramen the notch, which is situated at the under and fore part of the cavity, leaving a space for the passage of blood-vessels to the ligamentum teres. It is connected with the bony edge of the acetabulum by a comparatively broad base, while its apex is a free border a little inclined inwards. Its internal surface is covered by the synovial membrane; its external is in contact with the capsular ligament.

Synovial membrane.—This membrane arises from the cartilage of the head of the femur; it is then continued along its neck as far as its base, from whence it becomes reflected on the capsular ligament, covering it throughout its whole extent; it then passes on the inner surface of the cotyloid ligament into the cavity of the acetabulum, at the bottom of which it forms folds or fimbriæ, for the purpose of enlarging the surface for the secretion of its fluid; but, from its appearance, it has gained the name of a synovial gland; from thence it passes along the ligamentum teres to the head of the femur,—the point at which we began out description. As this membrane passes along the ligamentum teres, it excludes it from its secreting cavity, precisely in the same manner as the abdominal viscera are excluded from the cavity of the peritoneum. The whole circumference of the head of the thigh-bone has many little granular substances on it, which appear to be folds of the synovial membrane; there is one, in particular, to be found immediately below the insertion of the ligamentum teres. This articulation is provided with blood-vessels and nerves from the obturator artery and nerve, just at their passage through the obturator foramen, and also from the circumflex arteries.

Motions of the Hip-Joint.

The motions of the hip-joint are much the same as those of the shoulder, excepting that the rotatory motions are to a much less extent, in consequence of the greater depth of the acetabulum, in comparison to that of the glenoid cavity of the scapula, and of the stronger and shorter capsular ligament; but the joint is capable of flexion, extension, abduction, adduction, rotation outwards, rotation inwards, and circumduction.

First, flexion.—When the femur is flexed the thigh is bent upon the pelvis, and its inferior extremity is carried forwards; the great trochanter is thrust backward towards the sciatic notch; the head rolls in the acetabulum on its own axis. The capsular ligament is slightly stretched posteriorly; but, if flexion be carried to its greatest degree, the distension of the ligament becomes considerable, in proportion to the extent of action.

Secondly, extension.—This motion is produced by the inferior extremity of the thigh-bone being carried backwards; the trochanter major is brought forwards, and is situated immediately under the anterior and superior spinous process of the ilium. The capsular ligament is put upon the stretch, in consequence of the disposition of the head of the thigh-bone to leave the cotyloid cavity; it is forcibly pressed on the anterior part of its capsule, which is, in this situation, rendered stronger by the accessary ligament, already described.

Thirdly, abduction.—In this action the thigh is separated from the other laterally; the great trochanter is, when abduction is carried to its fullest extent, brought into contact with the dorsum of the ilium; the internal part of the capsular ligament, and the ligamentum teres are stretched.

Fourthly, adduction.—This motion consists of little more than the return of the limb to its natural position, after abduction has been performed; but it can be carried to a greater degree, so as to make the superior extremity of one thigh-bone cross the other; in which case the trochanter major is carried a little below, and anterior to, its natural situation. By this motion the outer part of the capsular ligament is slightly stretched.

Fifthly, rotation.—This may be either *outwards* or *inwards;* the former action seems to be more consistant with the position of the limb; and we find, therefore, an infinitely greater muscular apparatus to produce it, than to roll the thigh inwards. When this motion is carried to its greatest extent, the great trochanter is directed behind the acetabulum, and the head of the bone is thrown forward, pressing against the capsular ligament. In the latter case the inferior extremity of the femur is turned inwards, and the trochanter is so brought forward towards the spine of the ilium, as to make a perceptible projection under the skin; and the head of the bone turns upon its own axis, towards the back part of the acetabulum. In these rotatory motions, the foot should not be made the guide by which we can judge of their extent, as that is influenced by the motions of all the joints of the inferior extremity.

Sixthly, circumduction.—This is produced by the quick succession of all the motions of which the hip-joint is capable; and, as might be supposed from the structure of the joint, is limited to a considerably less extent than that in the shoulder. The ligaments and muscles adapt themselves to each motion as rapidly as they occur.

Practical Remarks.

Dislocations of the Hip-Joint.

Having ascertained the motions of which this joint is capable, we may easily understand the different directions in which the head of the thigh-bone may be thrown from the acetabulum.

First, upwards and backwards upon the dorsum ilii.

Secondly, backwards into the ischiatic notch.

Thirdly, downwards and forwards into the foramen ovale.

Fourthly, forwards upon the pubes.

Dislocation upwards and backwards on the dorsum ilii.—This is the most frequent luxation of the thigh-bone; and although in many respects it offers the same diagnostic marks as the other dislocations, yet there are some peculiar circumstances which render the nature of the accident at once obvious; and its most prominent characteristic is, the great degree of shortening of the limb, its rotation inwards, so as to bring the trochanter major much nearer to the anterior superior spinous process of the ilium; the foot, on the injured side, rests upon the tarsus of the opposite one, and the knee is partly flexed, and in advance of the other. The roundness of the hip is lost, in consequence of the ascent of the head of the thigh-bone upon the dorsum of the ilium, and the consequent relaxation of the glutei muscles; the pyriformis is somewhat relaxed, but the obturatores gemini and quadratus muscles are stretched. The psoas and iliacus are put upon the stretch, in consequence of their being drawn over the body of the pubes; but the other muscles arising from the pelvis, and inserted into the bones of the lower extremity, below the trochanter major, are relaxed, on account of the approximation of their points of attachment. The capsular ligament is torn through, so as to admit of the escape of the head of the bone, and the ligamentum teres is also lacerated.

The accidents with which this dislocation may be confounded are, the luxation of the head of the thigh-bone into the ischiatic notch, and the fracture of its neck; from the first it may be distinguished by the great degree of shortening, which causes the toe of the injured side to cross the tarsus of the opposite foot; while in dislocation into the ischiatic notch, the toe, on the dislocated side, is only directed to the ball of the great toe of the other foot. From fracture of the cervix femoris it is easily distinguishable, if but common attention be paid, for there is nothing similar in the two accidents excepting the shortening of the limb; the fixed position of the joint in dislocation, and its moveable state in fracture, will at once preclude the possibility of mistaking one injury for the other, as well as the inversion of the foot in the former accident, and its eversion in the latter.

Dislocation backwards into the ischiatic notch.—In this case the head of the bone is thrown behind the acetabulum, and a little above the centre of that cavity; so that the limb is somewhat shortened, and the foot inverted, with the great toe on the injured side resting on the ball of the opposite one. From the depth at which the head of the bone is placed, it is with difficulty felt resting on the pyriform muscle. This dislocation is, in every respect, the most difficult to discover; but the points to be observed are the loss of motion of the joint, accompanied by but slight shortening of the limb, not more than to half an inch, and by invertion of the foot. With respect to the modes of reduction of the dislocations of the hip-joint, it should be remembered by the surgeon, that his sole opposing force is muscle; and, therefore, that it is quite essential for him to understand the position of these organs under the different luxations of this joint, that his judgment may decide on the best means of placing them under those circumstances, in which they can offer the least opposition to his efforts in reduction; at the same time recollecting the necessity of the perfectly fixed state of the pelvis.

Having perfectly fixed the pelvis and relaxed the muscles of the hip-joint, the next object is to apply a sufficient extending force to reduce the limb; upon this subject there is some discrepency of opinion, as to the most advantageous situation for its application: some authors asserting that the inferior extremity of the femur is the best, being then applied to the dislocated bone itself; while others recommend its application to the ancle-joint, in order to remove it as far as possible from the opposing muscles, added to which, advantage may be gained from the increased length of the lever. The benefit resulting from this latter practice is frequently manifested, by surgeons succeeding to reduce dislocations of the humerus, by making extension from the wrist, after the application of the force to the bone itself has failed.

Dislocation of the thigh-bone downwards and forwards into the foramen ovale.—The diagnostic marks of this injury are so completely characteristic, as to render its nature at once obvious. The limb is lengthened to a considerable degree, the thighs are widely separated from one another, and the knee of the injured limb is advanced; the foot is somewhat everted, and the toes only, rest upon the ground; the pelvis is bent upon the thigh, in consequence of the state of tension incident to the psoas and iliacus muscles, and a flatness of the thigh is produced by the extended state of the muscles situated upon it. The head of the bone can be felt deeply seated on the inner and superior part of the thigh; the trochanter major is considerably moved from the anterior superior spinous process of the ilium; and the voluntary motion of the extremity is totally lost. The capsular ligament is lacerated, as well as the ligamentum teres, although some have said that the latter is not necessarily torn through; but the head of the bone cannot be thrown completely out of the acetabulum, in any direction, without producing such a consequence. The increased length of the limb, the separation of the thighs, and the bending of the body, are, therefore, the principal diagnostic symptoms.

Dislocation forwards on the pubes.—This is an accident of rare occurrence, compared with the two preceding; but it does occasionally take place: and may be at once known from any of the other luxations to which the thigh-bone is liable, by the outward rotation of the whole limb, by the head of the bone being felt just beneath Poupart's ligament in the situation of the anterior crural nerve, upon which it sometimes presses so as to produce numbness and pain. The trochanter major is nearer to the anterior superior spinous process of the ilium; and the impossibility of producing rotation inwards of the injured limb, sufficiently marks the nature of the accident.

This dislocation is the accident of all others most liable to be confounded with fracture of the neck of the thigh-bone; being alike characterized by shortening of the limb, and eversion of the foot; but the fixed state of the limb in dislocation, and the facility with which it may be moved in fracture of the neck, form an unequivocal distinction.

From the great strength of the muscles of the hip-joint, there are no luxations in the body which require so nice an adaptation of the force employed to overcome the antagonizing power; and we have frequent opportunities of observing how the scientific surgeon, with a comparitively slight force, succeeds in the reduction of a dislocated femur after an ill-adjusted greater violence had failed.

We have described, that the hip-joint is liable to four varieties of dislocation; perhaps it might be more properly said, that the head of the femur may be thrown from the acetabulum in any direction, radiating from its centre; but still, whatever may be this direction, it ultimately becomes permanently fixed in the situations which I have mentioned from the influence of the muscles.

Each of these dislocations require a different application of the apparatus, for fixing the pelvis and making extension on the dislocated limb. Each mode therefore requires a separate description. To restore the head of the femur to the acetabulum, when thrown upwards upon the dorsum of the ilium, the patient should be first bled from the arm by a free opening to approaching syncope, and this state maintained by the administration of nauseating doses of tartarized antimony; and so soon as the muscular powers of the patient shall be sufficiently diminished, he should be laid on his *back* upon a table of a convenient height, placed between two strong staples. A leathern-padded girth, with an opening in it sufficiently large to admit the injured extremity, is to be so adjusted as to press upon one side of the perineum; the two extremities are then to cross the crista of the ilium, so to be fixed to one of the staples as to form a line posteriorly, continuous with the direction of the dislocated limb. The pulleys for the extending force are then to be fixed around the lower part of the dislocated thigh, and hooked to the opposite staple, so as to form a continuous line with the direction of the dislocated limb, and the counter-extending force. Extension should be then gradually made upon the pulleys, and steadily maintained for a sufficient length of time, rather to weary than violently overcome the contending muscles. When the head of the femur is felt to move, the surgeon should attempt to adduct the knee, by which means the head of the bone is tilted outwards from the dorsum of the ilium, when, by a forcible rotation, the bone is usually drawn into the acetabulum.

For the reduction of the dislocation into the ischiatic notch, the apparatus is applied in a very similar manner as in luxations on the dorsum. The patient is, however, placed on the sound *side*, instead of on his back; and in consequence of the greater degree of flexion of the thigh upon the pelvis, the lines of the dislocated limb, with the extending and counter-extending forces, must cross the sound thigh at its centre, whereas, in the last description, it crosses its lower third. In this dislocation, a round towel should be placed under the upper part of the thigh-bone, so that an assistant, during the extension, may raise the head of the bone towards the acetabulum.

One of the greatest difficulties, which the surgeon has to encounter, during his attempt at the reduction in both of these accidents, is to ascertain when the bone is restored to its natural situation; for as both by medicinal and mechanical means he has subdued the power of the muscles, no snap can be expected to indicate the restoration of the articulatory surfaces, and it is only by a thorough knowledge of the relative distance of the trochanter major, from the anterior and superior spinous process of the ilium, and from the sacro coccygeal articulation, as well as from a perfect appreciation of the natural form of the hip-joint, that he is generally enabled to ascertain when his desired object is effected.

In dislocations into the foramen ovale the mode of reduction is regulated by precisely the same principles as those of other luxations, but yet the direction of the extending and counter-extending powers, differs very much from the other dislocations of the hip-joint. The patient should be placed upon his *back*, where the extending force is to be applied, by passing a girth around the upper part of the affected limb, so high as to be in contact with the perineum. The end of this girth is to be affixed to the hook of the pulleys. The counter-extending apparatus, for the purpose of fixing the pelvis, is completely to surround both ilia; at the same time being admitted through the noose formed by the girth attached to the luxated limb, and then being fastened to the opposite staples: the two girths, during the application of the extending power, are made to fix each other. The surgeon should now desire gradual extension to be made upon the pulleys, until the head of the femur can be felt moving from the foramen ovale; he is then to grasp the ancle of the dislocated extremity, and by adducting it in a direction behind the ancle of the sound limb, he acts upon the head of the dislocated femur with all the advantages of the power of the first order of lever, and usually by these means readily reduces the dislocation.

In the dislocation upon the pubes, the patient is also placed upon his sound *side*, during the attempt at reduction. The apparatus is applied in a very similar manner as in dislocations on the dorsum of the ilium, but with this variation,—that the line of counter-extension is carried immediately in front of the patient's face; and as the dislocated limb is so little displaced from the vertical axis of the body, the continuous line of the limb, and of the extending and counter-extending forces, is nearly parallel with the horizontal position of the body.

Articulation of the Knee; or, Femoro Tibial Articulation.

Class *Diarthrosis.*—Subdivision *Ginglimus.*

This is one of the most complicated joints in the body, and is produced by the union of the following bones:—The condyles of the femur, the superior extremity of the tibia, and the posterior surface of the patella, being covered in their recent state by articular cartilage, adapt themselves for the performance of the varied functions of this joint, These cartilaginous surfaces are covered by synovial membrane, to facilitate motion; and the following ligaments serve to prevent lateral movement, while they admit of flexion and extension.

The ligaments of the knee-joint may be divided into two sets: those which are external, and those which are internal. The latter, however, it must be remembered, are external to the synovial cavity, although nearer to the centre of motion than the former class. The external ligaments of the knee-joint are, an anterior, or ligamentum patellæ; a posterior, or the ligament of Winslow; two external, and one internal lateral ligament.

The *ligament of the patella* is, in fact, nothing more than a continuation of the tendons of the extensor muscles of the leg, which completely envelope the patella, becoming attached to its inferior edge or apex, and passing from it to the tubercle of the tibia; anteriorly, it is covered only by skin, and by a prolongation of the fascia lata; its posterior surface is in contact with fat, and the synovial membrane of the joint, and below a bursa is formed, between it and the tibia; its edges are in contact with the tendinous insertion of the vasti muscles, and with that portion of the synovial membrane which gains the name of the alæ ligaments. The fibres of this ligament pass from above to below, in parallel lines, which are strengthened by cross bands. It is generally about two inches in length, and is sufficiently strong to counterbalance the action of the extensor muscles.

The *long external lateral ligament* is posterior to the centre of motion, so as not to be put upon the stretch under the various actions of the joint. It is composed of vertical fibres, which descend from the external condyle of the femur to be attached to the head of the fibula; it is covered in a great part of its extent by the tendon of the biceps muscle, and its inner surface is applied to the external semilunar cartilage, and to the synovial membrane. The inferior articular vessels pass between this ligament and the bone. The origin of the external lateral ligament from the femur, is above the origin of the popliteus muscle.

The *short external lateral ligament,* which appears to be an accessory to the other, is placed posteriorly to it, and running in a parallel line, passes from the outer side and posterior part of the external condyle, downwards, to the head of the fibula, to which it is attached. These two ligaments are connected with each other by a strong cellular tissue.

The *internal lateral ligament* is also posterior to the centre of the joint. It is of a triangular form, its apex arising from the posterior part of the internal condyle of the femur, and its base being attached to the internal edge of the head of the tibia; its fibres are more flattened than the external ligaments of the knee-joint; it is rather thicker before than behind, where it is connected with the posterior ligament of Winslow by a strong aponeurosis. This ligament is covered above by the insertion of the vastus internus, and below by the sartorius, gracilis, and semi-tendinosus muscles; the ligament itself covers the synovial membrane, and is connected with the internal semilunar cartilage.

The *posterior ligament* forms a great protection to the back part of the joint. It passes transversely from without to within, arising from the external condyle of the femur, and being inserted into the back part of the tibia, where it is intimately connected with an aponeurotic expansion from the tendinous insertion of the semi-membranosus muscles; which muscle, in flexion of the knee, prevents this ligament from being pressed between the bones. This, at least, is the function usually ascribed to the attachment of that muscle to the posterior ligament; but I believe a much more important purpose may be assigned to it,—that of keeping the semilunar cartilages in their natural position under all the various motions of the joint. Its fibres take an irregular course, leaving several apertures for the transmission of blood-vessels; its posterior surface is covered by the popliteus muscle, its anterior is in contact with some fat which is interposed between it and the posterior crucial ligament, leaving a space for the transmission of the middle articular vessels.

The second class, or those ligaments which are described as within the knee-joint, although exterior to the synovial capsule, are the following.

The *anterior crucial ligament,* arises from the inner and back part of the external condyle, and is directed obliquely downwards and forwards to a depression in the front part of the spine of the tibia to which it is attached, between the anterior cornua of the semilunar cartilages: it is covered before, by the synovial membrane, and is in contact behind, and above with the posterior crucial ligament. This is the ligament, which in the semiflexed position of the knee-joint, prevents the rotation of the tibia inwards, excepting to a very slight degree.

The *posterior crucial ligament* crosses the direction of the preceding, arising from the internal condyle, and passing outwards, although not with the same degree of obliquity as the anterior, to be attached to the posterior part of the spine of the tibia; its course deviates but little from the vertical line; its base, which is connected with the tibia, is continued to be attached to the external semilunar cartilage; behind, it is covered by the posterior ligament of the joint, and by the middle articular arteries: while before, it is applied to the anterior crucial ligament.

The *semilunar cartilages* are situated between the condyles of the femur and the upper face of the tibia, which they render more concave: they are, as their name implies, of a semilunar form, and much thicker, at their greater than at their smaller circumference; they are less in extent of surface than the upper part of the tibia, not occupying more than its two external thirds, and are distinguished according to their relative situation, into internal, and external.

The *internal* is nearly semicircular, rather longer and larger behind than before; its convex edge is turned inwards, and is connected with the internal lateral ligament; its anterior extremity is attached to the spine of the tibia, and to the anterior crucial ligament; its posterior extremity is fixed to the tibia, and to the posterior ligament of Winslow.

The *external* forms a greater share of the segment of a circle than the preceding; is also larger before than behind; its convex edge is turned outwards, and is in contact behind with the popliteus muscle; in the middle part, with the external lateral ligament, and in the fore part with the tibia, being placed behind the anterior extremity of the internal cartilage; while posteriorly, it is anterior to the corresponding extremity of its fellow. These cartilages are composed of fibres, which are more perceptible in their convex than concave edges; they are anteriorly connected to one another by a short *transverse ligament;* their superior surfaces are concave, their inferior flattened, and both are covered by synovial membrane, which is reflected under their free concave edges. These two ligaments together, resemble the interarticular cartilages of other joints; leaving, however, a large opening between the two synovial cavities, which they have a tendency to separate.

The *synovial membrane* takes a course rather difficult to describe, as it lines the inner surfaces of all the ligaments, as well as the cartilaginous surfaces of the bones entering into the composition of the knee-joint. We will first trace it from the inner surface of the extensor tendons of the leg, just as they are inserted into the patella. From this point it proceeds upwards, lining the under surface of this tendon as high as the condyles of the femur, upon which it then becomes reflected, forming a *cul de sac* between the two; it passes round the extremity of the femur, as far backwards as the posterior ligament; at the same time surrounding the crucial ligaments, so as to leave them posterior to its cavity. From thence it is continued on the superior surface of the semilunar cartilages, lining also the external and internal lateral ligaments; it then dips under the concave free edges of the semilunar cartilages, covers the whole superior articular surface of the tibia, and proceeds from the anterior point of this bone to the inner surface of the ligament of the patella, extending laterally to the anterior edges of the two lateral ligaments. These attachments, from the points where they are connected to the edges of the ligamentum patellæ, are called the *alæ ligaments*. It then rises upon the inner surface of the patella, and passes from its base upon the tendon of the extensor muscles, from whence we began the description. There is also a portion of the synovial membrane, which passes from the tibia to the femur, between its condyles, like a chord, and is called the *mucous ligament;* it is composed of a number of little fimbriated processes, which receive the ramifications of the articular arteries.

Motions of the Knee-Joint.

The articulation of the femur with the tibia, forms a complete hinge-joint, which is anteriorly protected by the patella. With respect to the motions of this joint, it is capable of flexion, extension, and some slight degree of lateral motion, during the flexed position of the leg. When the limb is flexed, the leg is capable of being carried very far back, so as to form an acute angle with the thigh; during which motion, the semilunar cartilages are drawn backwards by the action of the semi-membranosus muscle; and the patella, as the femur and the tibia recede from each other, remains stationary, so as to protect the knee-joint, which would otherwise have been much exposed, during this action. This extensive motion of flexion is allowed, in consequence of the larger articular surfaces of the condyles of the femur, upon which the tibia moves, being placed posteriorly. In extension, the leg cannot be carried further forwards than to the straight line, during which action no lateral motion can take place in the knee-joint; and from the condyles of the femur being pressed against the origin of the gastrocnemii muscles, greater stability is given to the limb. The motions of the limb during the extension of the knee, are effected by the hip-joint; but in flexion, the tibia and femur move upon each other. During slight flexion, such as takes place in progression, we are capable, from the degree of lateral motion which under these circumstances the joint enjoys, to direct our steps, by a rotatory motion of the tibia on the femur, in a lateral direction; but this can take place to a much further extent outwards than inwards, in consequence of the attachments of the anterior crucial ligament. Whenever, therefore, lateral motion can be performed by the knee-joint, that limb is under circumstances least capable to resist accidents, or to support the weight of the body, which is consequently thrown entirely upon the other extended extremity, as we find to be the case in the act of walking.

Practical Remarks.

Dislocations of the Knee.

Dislocations of the Patella.—This bone being situated on the anterior part of the knee-joint, is much exposed to external violence, and is proportionably liable to injury; amongst other accidents, it is subject to dislocation, which may take place either outwards or inwards.

The *dislocation outwards* is the most frequent; it is, however, scarcely ever complete, unless it be from a very relaxed state of the ligaments, produced by some prior disease; but is usually thrown upon the external condyle, there forming a tumour, attended with loss of motion of the joint, which circumstances sufficiently point out the nature of the injury. This accident is frequently produced by a blow on the inner side of the patella, when the foot is everted, or it may be caused merely by the action of the extensor muscles of the leg; and in this case it most frequently occurs to such persons who have their knees directed very much inwards. If the dislocation be complete, the articular surfaces of the patella are thrown upon the external surface of the condyle, and its inner edge is placed anteriorly, which cannot take place without partial laceration of the ligamentum patellæ; unless, as I have before remarked, the accident be subsequent to the relaxation of the ligaments of the knee-joint from disease.

Dislocation inwards.—The appearances and symptoms differ in no respect from those of the preceding injury, excepting that the projection is situated internally instead of externally.

The *dislocations upwards* and *downwards*, which are spoken of by some surgeons, do not appear to me to deserve such appellation; but rather to be spoken of as either laceration of the ligamentum patellæ, when the bone is drawn upwards by the action of the extensor muscles, or as rupture of the tendon of the extensor muscles, when the patella is forced below its natural position.

The *mode of reduction*, when the patella is thrown either outwards or inwards, must at once be obvious to every surgeon; his object would be to place his only opposing force, the extensor muscles of the leg, in the greatest state of relaxation, which may be easily performed by laying the patient in the horizontal position, with the injured leg extended, and the thigh flexed; and then, by forcing the patella either inwards or outwards, according to the direction of the luxation, it is easily reduced. These means should be employed as soon after the accident as possible, and bandages subsequently used, to keep the bone in its natural position; from which it would otherwise be easily again displaced by muscular action alone.

Dislocations of the tibia.—The tibia may be thrown from the articular surfaces of the condyles of the femur, in four directions; but, in consequence of the large surfaces of bone, which are in contact for the formation of this joint, luxation is but rarely complete, and never without being accompanied with very extensive laceration of soft parts, unless, indeed, it be the result of protracted disease. But whatever may be the cause of displacement, the deformity is so great as at once to indicate the nature of the injury.

The tibia may be thrown forwards, backwards, or laterally, to either side of the knee.

Dislocation forwards.—In this luxation the head of the tibia is thrown before the condyles of the femur, which are thrust deeply into the popliteal region, so as to compress the popliteal artery. The leg is shortened, this effect being produced by the laceration of the crucial, lateral, and posterior ligaments; the extensor muscles of the foot, as well as the popliteus, must inevitably be stretched almost to laceration.

Dislocation backwards.—In this case the head of the tibia rests in the popliteal space; the leg is projected forwards by the pressure of the condyles of the femur upon the tubercle of the tibia; and the tendinous insertion of the extensor muscles of the thigh into the patella is torn through, leaving a depression above. Such is the account of this accident, as given by Sir Astley Cooper, from whom some surgeons differ as to the position of the leg, whether it be inordinately extended, or permanently flexed; but as Sir Astley Cooper's description is derived from the history of a case furnished to him by an able and zealous professional man, under whose care the subject of the accident was placed, I shall esteem the account as positive, and not to be refuted by theoretical reasoning.

In the *lateral dislocations*, the projecting deformity sufficiently points out whether the luxation be *inwards* or *outwards;* in the first case the tibia is so thrown inwards, as to receive the external condyle on its outer articulatory surface, and the tibia projects on the inner side of the joint. Appearances precisely similar, excepting in situation, occur in the displacement of the tibia outwards

The semilunar cartilages are sometimes partially displaced by the pressure of the femur, in consequence of relaxation of the ligaments of the knee-joint. This accident was first observed by Mr. Hey, of Leeds, and the symptoms have been most perspicuously and scientifically described by him, in his "Practical Observations on Surgery."

In few cases of dislocation of the tibia is there much diffiulty in returning the bone to its situation, by reason of the laceration of the ligaments; but great care is required to relax the muscles inserted into it, that their action may not again displace the bone. This object is best effected by bandages, and by the semiflexed position of the limb.

The constitutional remedies will, necessarily, be directed by the peculiarities of each particular case.

Articulation of the Tibia and the Fibula.

CLASS *Diarthrosis.*—SUBDIVISION *Arthrodia.*

These two bones are in close contact at each extremity; but in the intermediate space there is a natural separation between them, which is filled up by the interosseous ligament. In this respect they are similar to the bones of the fore arm, excepting that they are comparatively firmly fixed to each other, while a very considerable degree of motion is allowed between the radius and the ulna.

Upper Fibulo-Tibial Articulation.

There is a depression on the outer side of the head of the tibia, and a corresponding surface on the fibula, for the attachment of these two bones; each is covered with cartilage and synovial membrane, and their union is strengthened by an anterior and a posterior ligament.

The *anterior ligament* is of considerable strength and size. It passes from the outer part of the tubercle of the tibia outwards and downwards, to be attached to the head of the fibula, and is covered and rendered stronger, by the tendon of the biceps muscle.

The *posterior ligament* takes a very similar course to the preceding, being placed behind the articulation; its fibres are less strong, but support is afforded to it by the popliteus muscle, by which it is covered.

A *synovial membrane* lines the internal surface of both these ligaments, as well as the cartilaginous surface of the bones.

Notwithstanding the firmness of this junction, there is some slight degree of motion, from before to behind, between the upper extremities of the tibia and fibula; luxation does sometimes occur, either from relaxation of its ligaments, or the application of force, and the fibula may, from either of these causes, be thrust backwards; it is, however, easily replaced, but with difficulty retained in its situation, in consequence of the action of the biceps muscle; a strap should therefore be firmly applied, to retain it in its situation.

I had an opportunity of seeing this accident at Guy's Hospital, which was admitted under the care of my colleague and relative Mr. Key. In this case, there was a compound dislocation of the head of the fibula backwards from the tibia, attended with fracture of the fibula; the bone was so comminuted as to require the removal of its dislocated head: nevertheless, the patient recovered without sustaining any important alteration in the functions of the limb.

Middle Fibulo-Tibial Articulations.

The tibia and fibula are connected nearly throughout their whole course by the *interosseous ligament*, which, as in the fore arm, fills up the natural separation of the two bones. It presents an aponeurotic expansion, composed of oblique fibres, which extend from within to without, arising from the external edge of the tibia, and passing to the inner angle of the fibula, terminating below on that bone, so that it extends lower on the outer than on the inner side; and, as it forms an opening just above its termination, its lowest fibres, which pass from the inner side of the external malleolus to the tibia, are called the *inferior interosseous ligament*, which serves very considerably to protect the ancle-joint. The anterior surface of the interosseous ligament is covered by the flexor muscle of the foot, the extensors of the toes, and the anterior tibial vessels and nerve; its posterior face covers the extensor of the foot, and the flexors of the toes. At the upper part of this membrane, there is an opening for the transmission of the anterior tibial vessels, and some of the fibres of the tibialis posticus muscle. Through the lower interosseal opening, which I have already described, there passes a branch of the peroneal artery.

Inferior Fibulo-Tibial Articulation.

This articulation is formed by two triangular articular surfaces; that on the fibula being convex, and that on the tibia concave: both these surfaces are covered by cartilage: the synovial membrane of the ancle-joint lines their internal surfaces, and the following ligaments strengthen their union.

The *anterior ligament* is triangular, larger below than above, and it passes from the lower extremity of the fibula to the fore part of the tibia. Its anterior surface is covered by the tendon of the peroneus tertius muscle; it serves to strengthen the articulation of the astragalus with the tibia and fibula, by rendering the cavity deeper in the anterior part.

The *posterior ligament* is composed of two fasciculi, separated from one another by an intervening space; the inferior fibres are sometimes called the *inferior posterior ligament*. They both, however, arise from the back part of the malleolus externus, and pass inwards to be inserted into the back part of the tibia. The inferior fasciculus, or inferior posterior ligament, is longer than the superior, and crosses so behind the articular surface of the astragalus, as to prevent its luxation backwards. They together serve the same purpose as the anterior ligament, in rendering the articulation of the astragalus with the tibia and fibula much more secure, as well as in connecting those bones firmly together.

Articulation of the Astragalus with the Tibia and Fibula, or Ancle-Joint.

CLASS *Diarthrosis.*—SUBDIVISION *Ginglimus.*

The inferior extremities of the tibia and fibula form a socket for the reception of the upper part of the astragalus; this socket is rendered much deeper by the projection of the two malleoli on either side of the astragalus, and it is further completed by the anterior and posterior ligaments, which have just been described, connecting the tibia and fibula below. The surfaces of bone entering into this joint are covered by cartilage and synovial membrane, and are maintained in their situation by two ligaments from the tibia, and three from the fibula.

The *internal lateral* or *deltoid ligament,* is of a triangular form; its apex is attached to the internal malleolus; it then passes downwards, becoming broader as it descends, and is inserted into the inner side of the astragalus and os calcis; forming, where it is attached to the latter bone, a sheath for the transmission of the tendons of the long flexors of the toes and the tibialis posticus, which pass behind the internal malleolus to be inserted. There is also an *anterior ligament* from the tibia, which passes from the fore part of this bone to be attached to the anterior surface of the astragalus; and from the manner in which this ligament is connected to the lateral ligaments by condensed cellular membrane, the ancle-joint is sometimes described as having a complete capsular ligament: the tendons of the extensor muscles of the toes pass over it.

The *external lateral,* or *middle perpendicular ligament of the fibula,* is composed of straight fibres, which are strong, and rounded in their form, passing from the inferior extremity of the malleolus externus perpendicularly downwards, to be inserted into the upper part of the os calcis; its external surface is covered by the tendons of the peronei muscles; internally, it is lined by synovial membrane.

The *anterior ligament of the fibula* arises from the anterior part of the external malleolus, and passes downwards and inwards to be attached to the fore part of the astragalus.

The *posterior ligament of the fibula* takes much the same course as the preceding ligament, but is situated behind the joint; it passes from the back part of the malleolus externus, and is inserted at the posterior part of the astragalus, into the outer edge of the groove which lodges the tendon of the flexor longus pollicis muscle.

Synovial membrane.—This membrane secretes as large a quantity of synovia, as any in the body. It extends from the cartilaginous surfaces of the tibia and fibula upwards, between these two bones, as high as the inferior tibio-fibular articulation. It then prolongs itself on the cartilaginous surfaces of the two malleoli, covers all the ligaments of the ancle-joint, and rises upon the articulatory surfaces of the astragalus; before and behind it is very lax, and is connected with a considerable quantity of adipose membrane.

Motions of the Ancle-Joint.

The foot, through the medium of the ancle-joint, has the motions of flexion, extension, and lateral inclination.

Flexion.—During this motion the astragalus passes from before backwards, within the cavity formed by the tibia and fibula. The anterior ligaments are relaxed, and the posterior are put upon the stretch; but the lateral remain nearly in a quiescent state.

Extension.—In this action the foot is carried from the right angle, so as to form an obtuse one with the leg; the anterior part of the articular surface of the astragalus, leaves the cavity between the tibia and fibula, in the opposite direction to that in which it was kept by the last motion; and the posterior and smaller part of the astragalus passes forwards. In this action the lateral motion of the joint is allowed, in consequence of the comparatively smaller size of the astragalus behind, by which it is incapable of filling up the whole space between the tibia and fibula. During extension of the foot, the anterior ligament is put upon the stretch, the posterior is relaxed, while the lateral remain unaltered as to their degree of tension.

Lateral motions are extremely confined under every position of the joint; in fact, they can scarcely be separately distinguished from the motions of the bones of the tarsus between each other. They may, however, be performed to some small extent, under the circumstances that exist during the extension of the foot, as already described; and therefore, this being allowed, a partial circular motion must be ascribed to the joint, although it is capable of performing it only to a very confined extent, even in this position: in which state, the foot enjoying the greatest degree of motion, it is then in the position of all others in which the ancle-joint is liable to injury: while, on the contrary, in the erect posture, when this joint is sustaining the whole weight of the body, it is in its firmest state, and best capable of resisting injury from external violence.

Practical Remarks.

Dislocations of the Ancle-Joint.

Notwithstanding the numerous and strong ligaments which serve to connect the tibia and fibula with the bones of the tarsus, yet, from the great degree of violence to which the ancle-joint is constantly exposed, luxation does frequently occur; and as it is usually attended with great injury and laceration to the parts entering into the composition of the joint, the accident is one of a dangerous nature.

The astragalus may be thrown from the tibia in four different directions; but the fibula, having its ligaments so strong in proportion to its articular surface, usually breaks, rather than separate from its connexion with the astragalus.

The astragalus may be thrown inwards, outwards, forwards, or backwards.

The *dislocation of the head of the astragalus inwards*, is the most common; and in this accident the sole of the foot being turned outwards, its inner edge only rests upon the ground; the internal malleolus is depressed, and occupies a space on the inner side of the astragalus below its articular surface; the fibula is broken about two inches above the joint, and the lower portion is drawn by the tibia across the astragalus; the external malleolus remaining in its natural situation. If this accident be produced by a person jumping from a considerable height, that portion of the tibia which is connected to the fibula by the anterior and posterior ligaments, is liable to be broken off.

To effect reduction of this accident—The patient should be placed on his injured side, with the leg bent at right angles with the thigh, for the purpose of relaxing the muscles of the calf of the leg, upon which the facility of reduction depends; the foot is then to be extended by an assistant, while the surgeon presses the tibia forcibly outwards, the thigh at the same time being firmly fixed.

Dislocation of the astragalus outwards.—This accident is attended with comminution of bone, and considerable injury to soft parts; and in every respect offers a less favourable prognosis than the preceding luxation. The sole of the foot is turned inwards, resting on the outer edge; the malleolus internus is broken off the shaft of the tibia; and the fibula, at its lower extremity, is usually fractured. But it is said sometimes to happen, that the ligaments connecting the fibula to the tarsus, are ruptured; and, in that case, the bone remains whole. The external malleolus projects forcibly on the outer side of the foot, so as to threaten the laceration of the skin.

To reduce this dislocation, the patient should be placed upon his back, with the thigh bent upon the pelvis, and the leg upon the thigh; extension is then to be made from the foot, and the tibia is to be pressed towards the astragalus, while the sole of the foot is to be rotated outwards.

Dislocation of the astragalus backwards, is produced by the tibia passing forwards off the articular surface of the astragalus, and resting upon the navicular bone; the consequences are, great shortening of the foot between the lower part of the leg and extremity of the toes, together with elongation of the heel; the foot is extended and fixed in this position, admitting of no motion; the fibula is broken, its ligaments of course remain whole; but some of the posterior fibres of the deltoid ligament are liable to be ruptured. This dislocation is sometimes only partial; one half of the articular surface of the tibia resting upon the astragalus, while the anterior half projects forward over the navicular bone; the foot is extended, and the fibula broken; but it may be at once distinguished from the complete luxation, by the shortening of the foot and elongation of the heel being infinitely less than in the preceding accident.

Dislocation of the astragalus forwards.—This is an accident of extremely rare occurrence, for it appears never to have fallen under the observation of any author who has written upon the subject of dislocation; but should it occur, the lengthened state of the anterior part of the foot, with the shortening of the heel, would at once form sufficient diagnostic marks to point out the nature of the injury. Luxations incident to the ancle-joint, may occur in the compound as well as in the simple state; and the grand distinction between the two accidents, is, that in the latter case the synovial cavity is laid open by the laceration of the soft parts, and the articular surfaces of bone are exposed. Even in these accidents it is now proved by experience, that amputation is not the necessary result; for if there be youth and constitution, the preservation of the limb should be attempted in every case where there is not a division of any large blood-vessel, or any extraordinary degree of laceration of the soft parts; and it may very frequently be effected by strict attention to the unfavourable symptoms that supervene, and the judicious application of remedies to overcome them,

With respect to the reduction of these dislocations, whether simple or compound, the means should be employed as soon as possible after the accident; and in all cases the leg should be flexed, which relaxes the opponent muscles. After the reduction has been completed, the foot should be well supported by splints, and a "foot piece," to present its liability to eversion, which would inevitably occur without this precaution.

Articulations of the Bones of the Tarsus.

The bones of the tarsus, at those points in which they come in contact, are covered with cartilage and synovial membrane; and their attachments are strengthened by strong ligaments, which may be distinguished on the plantar, dorsal, external, and internal regions of the foot.

Articulation of the astragalus with the os calcis.—These two bones are articulated by two cartilaginous surfaces, which are covered by synovial membrane, and maintained in their situation by an interosseous, a posterior, and an external lateral ligament.

The *interosseous ligament* is formed of strong thick fibres, which are situated between the astragalus and os calcis, being attached to the fossæ which separate the articular surfaces, on each of those bones. This ligament is thicker on the outer than on the inner side.

The *posterior ligament* arises from the back part of the astragalus, and directs itself obliquely inwards to be inserted into the corresponding part of the os calcis; it is connected with the groove which is formed in the os calcis for the passage of the flexor tendon of the great toe.

The *external ligament* forms a rounded fasciculus, the fibres of which run in the same direction as the external fibulo-tarsal ligament, passing from the external face of the astragalus to the outer surface of the os calcis.

Articulation of the os calcis and os naviculare.—In this articulation the surfaces of bone are not in contact, but the union is formed by two very strong ligaments,—the inferior or sub-astragular, and external ligament.

The *inferior* or *sub-astragular ligament* is very firm, and almost cartilaginous in its texture: it extends from the smaller tuberosity of the os calcis as far as the inferior surface of the navicular bone: in its passage from one bone to the other it rests, below, upon the tendon of the tibialis posticus muscle; and above, it receives a portion of the astragalus. It is this ligament which is of such essential service in preventing violent concussion to the foot on jumping from a height; for being rather fibro-cartilaginous than true ligament, its elasticity, combined with its flexibility, renders it well calculated to resist injury from external violence, as well as to admit of the general motions of the foot.

The *external ligament* is composed of very short fibres, which stretch from the anterior part of the calcis, to the inferior and outer edge of the navicular bone.

Articulation of the astragalus to the os naviculare.—The anterior extremity of the astragalus is rounded and fitted to a concave surface upon the posterior extremity of the navicular bone, both of which surfaces are covered by synovial membrane, and strengthened by one broad superior ligament, which covers the whole superior surface of the two bones: it is composed of very thin fibres, which are directed from behind to before. Some of its anterior fibres pass to the cuneiform bones.

Articulation of the calcis to the cuboid bone.—The articular surfaces of these two bones, which are in contact, are maintained in that situation by two ligaments, and covered by synovial membrane.

The *superior ligament* stretches from the superior and anterior part of the os calcis, to the superior surface of the cuboid bone. This ligament covers the synovial membrane, and is covered by the peroneus tertius muscle.

The *inferior plantar ligament* is very thick and extensive: it is composed of two sets of fibres, the superficial and the deep. The *superficial ligament* is the strongest of the tarsal ligaments: it is attached, behind, to the posterior and inferior part of the os calcis; and anteriorly, in part to the tuberosity on the inferior surface of the cuboid bone, and also to the extremities of the metatarsal bones of the little toe and toe next to it. The *deep*, or *superior plantar ligament*, has the same attachment to the os calcis and the os cuboides as the preceding ligament, but is above it, and separated from it by a layer of fat.

Articulation between the os naviculare and os cuboides.—These two bones are connected together by two strong ligaments; one being situated on the dorsal region of the foot, and the other on the plantar. The *dorsal ligament* is of a square shape: its fibres take a transverse course from the navicular to the cuboid bone. The *plantar ligament* is composed of stronger fibres, and passes from the inferior and external parts of the navicular to the cuboid bone.

Articulation of the cuboid with the external cuneiform bone.—These two bones present articular surfaces, which are in contact, and are covered by synovial membrane; they are maintained more firmly in their situations by a *dorsal* and a *plantar ligament*, which pass from the superior and inferior surfaces of one bone to the other, covering the synovial capsule.

Articulation of the navicular with the cuneiform bones.—The anterior face of the navicular bone presents three surfaces for the junction of the three cuneiform bones, which are covered with cartilage and synovial membrane. Three dorsal, and three plantar ligaments also enter into the formation of their union. The *dorsal ligaments* pass from the superior and anterior surface of the navicular, to be attached to each of the cuneifrom bones. The *plantar ligaments* take precisely the same course, but are situated in the sole of the foot.

Articulation of the cuneiform bones.—The cuneiform bones are attached to each other at their sides, each presenting an articular surface, which is covered by synovial membrane, and strengthened by three superior and three inferior ligaments.

The *superior ligaments* pass transversely from one bone to the other, forming a species of interosseous ligament. The *inferior ligaments* are precisely similar in their course, but are situated in the plantar region of the foot.

Articulation of the tarsus and metatarsus.—The three first bones of the metatarsus are articulated with the cuneiform bones; and the two last, or outer ones, with the cuboid. Their articular surfaces are covered with cartilage and synovial membrane, and are further united by dorsal and plantar ligaments.

The *dorsal ligaments* are composed of thick, short, parallel fibres, three of which pass from the superior part of the cuneiform bones, to be attached to the extremities of the metatarsal bones; and the outer ones pass in the same manner, from the superior surface of the cuboid bone, to the two outer metatarsal bones. The *plantar ligaments* are also five in number, and are disposed precisely in the same manner.

Articulation of the metatarsus.— All the bones of the metatarsus, excepting the first, are in contact with each other at their superior extremities, and present small articular surfaces, which are covered with synovial membrane, and maintained in their respective positions by *dorsal* and *plantar ligaments*, of which there are three on each region, passing transversely from one bone to the other, excepting from the first to the second.

The *interosseous ligaments* are also situated between the metatarsal bones, and serve to strengthen the articulation of these bones, and to give origin to the interossei muscles.

Transverse ligament.—The anterior extremities of the metatarsal bones are united by this ligament, which passes from the inferior extremity of one bone to the other, precisely in the same manner as in the metacarpus.

Articulation of the metatarsus and phalanges.—The superior extremities of the phalanges are articulated with the heads of the metatarsus; and they are connected by ligaments similar to those which form the junction between the phalanges and metacarpus.

The *articulation of the phalanges of the toes,* is so precisely analogous to that of the fingers, as to render its further description quite useless.

The *motions* between the bones of the tarsus, are but very slight; there are, however, two very important joints which cross the tarsus in a direct line; the inner one is formed by the astragalus and navicular bones, and the outer one by the os calcis and the cuboid. Slight lateral motion is allowed between these bones.

Practical Remarks.

Dislocation of the Bones of the Tarsus.

Their motions being limited, and their bonds of union firm and strong, luxation is of rather rare occurrence, and can only be produced by great violence; under which circumstance, however, the astragalus may be separated from the os calcis, and the os calcis and astragalus may be luxated from the cuboid and navicular bones. The internal cuneiform bone is also liable to dislocation.

The other bones of the tarsus and metatarsus are too strongly connected to admit of separation, unless, indeed, it be attended with such laceration of soft parts, and comminution of bone, as to threaten the total destruction of the foot.

The phalanges of the toes are so short, as to render their displacement an improbable accident; excepting that of the first bone of the great toe from the metatarsal bone, which not unfrequently occurs, but is easily reduced.

LECTURES ON ANATOMY.

PART III.

THE SKELETON IN GENERAL.

LECTURE XI.

THE SKELETON.

By the skeleton is meant the assemblage of all the bones of an animal, united in their natural situation, either by means of their own ligaments, or by some foreign substance: the former being called a natural, the latter an artificial skeleton.

The skeleton of the human subject constitutes a symmetrical figure, both as regards its form and dimensions; according to which, the figure and proportions of the whole body are in a great measure determined. We find that the body may be divided, by an imaginary middle line, into two distinct symmetrical halves, producing thus an evident lateral correspondence; and in no system is this more obvious than in the osseous, although, indeed, the same principle applies to the general contour of the body. But so perfect is the division in the osseous system, that even the azygos bones are so centrically situated, as to admit of a corresponding division by an imaginary mezian line.

The skeleton is divided into the *head, trunk,* and *extremities.* The trunk, which constitutes the most considerable of these divisions, is formed of a middle line,—the vertebral column, which must be considered as a most important part of the skeleton, forming in fact, the great bond of union to all the rest of the bones. Its superior extremity is greatly developed and expanded, constituting the skull; while the rest of its extent belongs to the trunk, composing, in part, the neck, thorax, and abdomen.

The head and trunk present two great cavities; the superior and posterior one, formed by the bones of the cranium and vertebral canal, lodging the brain and the whole of the central portion of the nervous system; the other is anterior and inferior, is called the thorax, and lodges the central organs of respiration and circulation. Other cavities are to be found in this part of the skeleton, principally formed by the bones of the face, and serve for the reception of the organs of the senses.

The extremities are provided with many and various articulations, admitting of a great variety of motion; and are, indeed, in every way admirably adapted to the purposes for which they are designed. On examining the circumstances in which the superior and inferior extremities resemble each other, we find an increase in the number of bones towards their distal extremities, whilst their mobility diminishes; excepting, however, the comparative greater degree of motion in the articulations of the phalanges of the fingers and toes, than is admitted between the bones of the carpus, and tarsus.

The upper and lower extremities further resemble each other, in the number of parts into which each may be divided, and in a corresponding form and number of their bones. Thus the most cursory observation must shew a considerable analogy between the scapula and the clavicle of the upper extremity, and the ossa innominata of the lower; the humerus corresponding very obviously to the femur, the radius and ulna to the tibia and fibula, and the hand to the foot: but yet there are many points of dissimilarity worthy attention, as tending to render them subservient to the difference in the functions they have to perform. The upper extremities are principally intended for very extensive motion, having but a slight comparative degree of weight to support, when compared to the lower. We therefore find the former most perfectly adapted to every variety and extent of motion, being but loosely connected with the trunk; while the latter are much more firmly articulated, and are in every way calculated to sustain the superincumbent weight of the body.

The relative, as well as the absolute dimensions of the skeleton, change much with the age of the individual. Thus, the proportion of the head to the rest of the trunk, and the extremities, progressively diminishes from the earliest periods until adult age; for in the earlier periods of uterine gestation, even in the second month after conception, the head forms a half of the whole length of the body; a fourth part at birth, about a fifth at the third year; and it amounts only to the eighth part of the whole, when the full growth is accomplished.

In early life the face is small in proportion to the cranium, the thorax in proportion to the pelvis, and the extremities in proportion to the trunk. The different sexes present also manifest distinctions in their skeletons: thus it is found, that the skeleton of the female is more delicate, and smaller than that of the male, whether we consider it as a whole, or the bones individually. The thorax of the female skeleton is shorter, smaller, but more moveable; the pelvis, on the contrary, is larger, especially in its lateral dimensions; and the lumbar region is infinitely elongated. It may be said, indeed, if a minute comparative view be taken, that not only all the regions of the body, but that almost all the bones present some special differences in the skeletons of the two sexes.

The different races of mankind present also great variety in their skeletons; some of these varieties are, however, attributable to the effects produced by artificial contrivances; as, for instance, the flattened head of the Caribbee, and the distorted foot of the Chinese female. But all varieties of form, which distinguish different races, are not to be explained by the habits alluded to; for a natural difference seems to exist in regard to the form and the dimensions of the cranium, and its proportions to the face: also in the proportion of the length of the extremities: in many of the negro race, the upper extremities are large in proportion to the trunk; and the fore arm and the foot are large in proportion to the arm and leg. That there are original national varieties of form, is proved by the inspection of the fœtus, in which distinguishing peculiarities already appear.

But not only is there to be found varieties in the form and proportions of the parts of the skeleton, at different periods of life of the different sexes, or in the skeletons of the different races of mankind, but also variations occur in the dimensions, configuration, and symmetry, in the skeletons of individuals of the same age, sex, and nation. Thus, for instance, the skeleton of a full grown European measures about five feet six inches in the male, and about five feet one in the female; this, however, is subject to a great variety, from such causes as prevent the uniform developement and growth of the body; for we find the skeleton of a dwarf may measure only the half of the normal size, whilst that of the giant may surpass it by half, but rarely if ever more than this. Some skeletons offer similar variations in the proportions between the trunk and the extremities, or between the extremities themselves, necessarily owing to variations in the length of the bones: they also sometimes differ in their configuration and symmetry.

The superiority in the developement of the bones of the right over the left side of the body, is often very decided; and there can be no doubt of its being produced by the more frequent application of their use.

Considering the number and the importance of the diseases which have their origin and seat in the various parts composing the skeleton, and which come especially under the practice of the surgeon, it would be almost a dereliction of duty on the part of a lecturer on anatomy, to an audience of intended surgeons, were he to dismiss his lecture on the skeleton of the human subject, without offering, at least, a few general hints as to the configuration and relative position of all its principal parts, in order to illustrate by so doing, as well their admirable adaptation to the performance of their respective functions, as the most rational and judicious means to be pursued in repairing the injuries to which they are liable, on rational and anatomical principles.

And first, if we turn our attention to the cranium, or skull, and consider that it lodges the brain—a substance in its nature so tender and susceptible of injury, that even the slightest local pressure is often sufficient to disturb its function, and which consequently requires some very solid covering to protect it—we shall find that it is constructed like an architectural vault, by which it is best able to counteract pressure, and to resist the influence of violence. We further find, as a means of protection to the important organ contained within the skull, that the arch formed by the two parietal bones is not perfectly circular, but that there is a projection at the centre of each, and that they are thicker and more convex at this part, by which these two bones afford, according to the principle of arches, an important protection to the temporal as well as to the sphenoid bone, in cases of violent concussion. It may also be observed, that all those parts of the skull which are most exposed to injury from external violence, are the most strong, from their greater convexity and thickness. But the *sutures* also give great security to the arch of the cranium, which are not only well adapted, by their dove-tailing construction, to hold each bone in its natural situation, but at the same time that they give strength to the whole apparatus, they serve to obviate the effects of concussion upon the brain.

During the early period of life, we find the cranium, as at birth, remarkably yielding and elastic; and hence it is, that the many falls and accidents incident to that period, occur for the most part with impunity; and again, if we examine the texture of the cranium in the adult, we find that it consists of two layers or tables, with a soft diploe between them: the outer table being very tough, is well calculated to resist such blows as might injure the brain by concussion; while the inner layer is hard and brittle, well calculated to resist any thing penetrating from without.

Regarding the developement of the cranium, not only is it soft and yielding at birth, but the sutures at this period, as well as a portion of the bones which enter into their formation, are in a state of cartilage; and hence it is that during parturition, the bones of the skull overlap at their edges, and thus diminish the size of the head. During childhood, as already remarked, the skull is elastic, and but little liable, therefore, to sustain injury from concussion: and during youth, up to the period of manhood, we find the periphery of the skull in parts thickened in proportion to the rest, the sutures perfected, the diploe developed, and every means employed to protect the brain, at that period of life when all the functions are most powerful and active: and lastly, in advanced age, all these apparent provisions against injury actually disappear; and the slow, cautious step of age, points out how ill fitted the bones of the skull then are to resist the ill effects of concussion upon the brain.

Having said thus much on the general structure, configuration, and provisions against injury of the skull, I shall conclude this part of my subject by briefly adverting to the varieties observed in the skulls of the different races of mankind.

Although in distinguishing the varieties of the human race, there are many points of the organization which claim attention, the peculiarities in the form of the cranium are the most striking and important, and it is on them that Blumenbach has principally founded his five grand divisions of the human race.

First.—In the *Caucasian*, *European*, or white variety, the head is of the most symmetrical shape, often almost round; the forehead is of moderate extent, but full, and not retreating; the face bears the smaller proportion to the rest of the head, it is oval and straight; the nose narrow and aquiline; the cheek bones rather narrow, without any projection, but having a direction downwards from the malar process of the frontal bone; the alveolar edge is rounded, and the front teeth of each jaw are placed perpendicularly; the chin is full, round, and somewhat prominent.

Second.—In the *Mongolian*, *Asiatic*, or brown variety, the head is almost square; the forehead broad and flat; the proportion of the cranium to the face nearly one tenth less than in the European; the face broad and flattened; the cheek bones projecting outwards; the nasal bones, and the space between the eyebrows, nearly on the same horizontal plane with the cheek bones; the space between the eyes very broad.

Third.—The *American*, or red variety, like the Mongolian, is characterized by the considerable breadth of the cranium; the forehead is somewhat retreating; the cheek bones are large and prominent, but are rounded, instead of being angular like those of the Mongolian; the nasal bones are flattened, but more prominent than in the Mongolian; the orbits are remarkably deep and large; the nasal cavities are likewise large; the occiput is said to be somewhat flat, and the protuberances which mark the seat of the cerebellum, not very prominent. The skulls of Americans are light; and, as it would appear from a circumstance related by Azzara, and quoted by Dr. Pritchard, they more rapidly decompose after interment than the skulls of Europeans.

Fourth.—In the *Æthiopian*, or black variety, the head is compressed and narrow; the forehead is very convex; the face bears the largest proportion to the cranium; the superfices of the face, relatively to that of the cranium, being one eighth larger than in the European; the cheek bones and jaws project forwards; the alveolar edge is long, narrow, and elliptical; the front teeth of the upper jaw are turned obliquely forwards; the lower jaw is strong, and very large; but the chin is retracted. The whole skull is thick, and heavy.

Fifth.—The character of the *Malay, Australian*, or tawny variety, is marked by the head approaching more nearly to the laterally compressed form of the Æthiopian, than to the breadth of the Mongolian; but the cranium bears a larger proportion to the face: the summit of the head is narrow; the forehead is somewhat arched, and frequently capacious; the vertex elevated, and the prominence of the parietal bones often strongly marked; the cheek bones not prominent, but broader than in the Æthiopian; the lower jaw rather projecting. Several skulls in the museum at Guy's Hospital, belonging to this race, are in good proportions; but there is in all, a disposition to preponderance of the posterior part.

Pritchard makes but three varieties of form in the head:—

Narrow—Æthiopian and Malay.

Intermediate—European, or Caucasian.

Broad—Mongolian and American.

Individuals in each of these races may, however, more or less, approach to one of the others; and it therefore requires strict investigation, and a combination of the distinguishing marks, to enable the craniologist correctly to class them.

In some nations, the form of the head is artificially modified; this is more particularly remarkable amongst the Æthiopians, and Americans. Humboldt has remarked, that these artificial forms are the exaggerations of such as belong to their particular race: thus the North American Indian, whose forehead naturally retreats, pushes it backwards to a preposterous extent, by means of pressure.

In consequence of the foramen magnum being placed much more anteriorly in man than in other animals, some physiologists have attempted to classify the different races of mankind by its relative position; and even in the human race, the form and position of this aperture is said not to be uniform, but has been considered to be larger, and placed more posteriorly in the Æthiopian than in any of the other races: yet Soemmerring, who has paid great attention to this subject, admits this is a questionable point. In the North American Indians, near the Copper-mine river, who are remarkable for the before-mentioned depression of the forehead, the foramen magnum is found placed forwards—a fact which, if any doubt could exist respecting the use of artificial means in modifying the head, would strongly tend to remove it.

The *spine*, or *vertebral column*, serves three important purposes in the animal economy. It forms the great bond of union between all the parts composing the skeleton: it lodges and protects the spinal marrow, and supports the head, which, indeed, according to some anatomists, has been considered a mere assemblage and modification of vertebræ. When we examine the mechanism of this column, we find it well adapted to the functions it has to perform, as it unites in itself the three different physical properties of *elasticity*, *flexibility*, and *strength*; thus possessing those qualities which render it best calculated to support weight, and to defend its important contents.

The great *elasticity* of the spine is owing to a soft, elastic, intervertebral substance, which is found between each two of the twenty-four vertebræ. But it is not the elasticity alone of this substance, which so admirably adapts it to the performance of its office, but also a gelatinous, almost fluid, central structure, which, being but little compressible during the erect position of the body, does not yield in the same degree as the circumference of this fibro-cartilaginous tissue, and thereby admits of the twisting of the spine as if on a pivot.

The form of the spine, which, when viewed laterally resembles an italic *S*, also offers great advantages, by being able to yield in the direction of its curves, and thus admit the operation of its elasticity without a jerk, so that no jar or concussion is communicated to the brain during the more violent motions of the body.

The natural curvatures of the spinal column are, in a great measure, caused by the action of muscles, and are therefore less marked in the younger periods of life; yet not produced as if they were merely accidental effects, but evidently as means and ends, contributing to balance the weight of the body on its centre of gravity, when either standing or walking.

The well-formed vertebral column in the dorsal aspect, is for this reason, always *convex* from the os coccygis to the junction of the sacrum with the ilia, and from thence *concave* upwards, as high as nearly the junction of the true ribs with the dorsal vertebræ; from whence, again, it becomes *convex* to the neck, and at last *concave* to the atlas.

Dr. Barclay has explained the formation of these curves in the following manner:—The sacrum is presenting its dorsal convexity by the resistance of the ilia towards its middle, the pressure of the whole trunk at one of its extremities, and the force of the gluteus maximus at the other. The concavity from the sacrum to the true ribs, by the action of the sacro-lumbales, and longissimi dorsi, to maintain the erect posture by preventing the centre of gravity falling forwards, and in raising the body from the horizontal posture. The concavity of the cervical region in its dorsal aspect, is produced by the preponderating power of the extensor muscles of the head and spine over the flexors. While the convexity of the dorsal region is the result of the centre of gravity of the thorax, and its contents, being sternad of the centre of motion.

The curved form of the spine anteriorly is, moreover, essentially serviceable: in the first place, from the manner in which it is articulated with the occiput, posteriorly to the centre of gravity of the skull; for if the spine proceeded in a straight direction towards the pelvis, it would have to bear the weight under great disadvantages; but by the curve the cervical portion of the spine takes forward, it is brought in the axis of the weight, and thus diminishes the necessity for constant muscular action to keep the head erect; whilst this position of the cervical vertebræ is further useful from inclination forwards, in sustaining the pharynx and larynx. In the next place, the dorsal vertebræ curve backwards, so as to enlarge the posterior dimensions of the thorax: the full extent of the convexity of this part of the spine backwards, is brought to a line perpendicular to the attachment of the atlas with the occiput. From thence the lower dorsal vertebræ pass slightly forwards and downwards to be connected with the lumbar, the upper of which form a convexity forwards, to such a degree as to be on a line perpendicular to the centre of gravity; from thence they pass backwards to a considerable extent, that the last lumbar vertebra may be articulated with the sacrum, so as to diminish the shock that would otherwise be communicated to the spine, in a direction perpendicular to the skull.

The *flexibility* of the spine is secured by the column being composed of twenty-four pieces, which are connected with each other by moveable articulations; and although there is but a slight degree of motion permitted between any two of these bones, yet the combination of the motions of all amount to an extent sufficient to produce necessary adjustments of the body.

The *strength* of the spinal column is secured by each vertebra consisting of a double arch of bone, rendering it thereby well adapted to counteract external violence, and forming at the same time a cavity for the spinal marrow. The size of the vertebræ increases from above to below, in a proportion equal to the accumulation of weight they have to support as they descend towards the pelvis. The great strength of the entire column is evinced by the weight man is able to bear upon his head, or upon his back.

The spine of the human subject rests on the sacrum, one of the bones of the pelvis, at an angle which has been already noticed as highly beneficial in preventing concussion; but this is not the only provision which nature has made against injury to the brain and spinal marrow; for the sacrum is so joined to the other bones of the pelvis, by fibro-cartilaginous tissue and ligaments, that it may be rather said to hang to them in slings than to form any true joint; and hence it is, that violence inflicted on the pelvis can only in a comparatively slight degree be communicated to the spine.

The *chest*, or *thorax*, which is composed of the twelve dorsal vertebræ behind, the twelve ribs on either side, and the sternum in front, forms a conical cavity for the lodgment of the organs of respiration and circulation. These bones are so articulated, that they not only serve to protect these organs, but are enabled, in consequence of the mode in which the ribs are connected with the vertebræ and sternum, to allow of a freedom of motion—such a motion as shall not interfere with the flexibility of the spine, and at the same time admit of a constant and uniform dilatation and contraction of the chest in the act of respiration.

It will be perceived that the ribs and sternum, at least, present those physiological characters assigned to flat bones in general; their form and arrangement being such as to contribute to the protection of the viscera contained in the cavities which they form, as well as to assist in the performance of the function of the viscera themselves. The elasticity of the cartilages forming the anterior portion of the ribs, tends also to facilitate their motions in the act of respiration, whilst, at the same time, it is calculated to obviate the effects of violence inflicted on the chest; and hence it is too, that when from age this elasticity is impaired or destroyed, hurried and laborious respiration becomes distressing to the individual, whilst violence is more likely to produce fracture.

The *upper extremities* have already been mentioned, as enjoying a great degree of motion; and if we examine, we shall find that each joint possesses an organization admirably adapting it to the offices nature has destined it to perform; and as the motions of the extremity as a whole are performed by the shoulder-joint, as we should naturally expect, we shall find the means employed to procure its extensive and various motions the most perfect. In the first place, the scapula, which forms the shallow articular depression for the head of the humerus, is connected with the trunk by numerous muscles, which are capable of giving motion to it in a greater or less degree in every direction, so that all the motions of the shoulder are increased by those of the scapula. The articular cavity being shallow, and the head of the humerus forming the part of a segment of a large circle, as well as the length of the capsular ligament, also fits this articulation for extensive mobility. These circumstances all rather tend to increase the extent of motion of the shoulder-joint, than to give it strength; but yet the easy mobility of the whole apparatus prevents its readily receiving injury from external violence. The scapula is further to be considered as useful, both from its arched form and situation, in defending posteriorly the organs of the thorax from injury. The os humeri is not perfectly cylindrical, but has ridges which serve to give strength to the bone, and attachment to its muscles. In all classes of animals the humerus is single, and it may be said to be shorter accordingly as the metacarpus is lengthened.

The *elbow-joint* is formed of a number of eminences and depressions of bone, which are so perfectly adapted to each other, as to prevent any motion but in the direction of flexion and extension. The humerus, ulna, and radius, all assist in forming the elbow-joint; but the radius, it is to be remembered, moves upon the humerus, for the performance of a function independent of this articulation, and which produces the pronation and supination of the hand. This joint is so strongly and firmly secured, by the form of its articular apophyses, as to be but little liable to dislocation when we consider the extent of motion it enjoys.

The *fore-arm* is composed of two bones, which are separated from each other in their middle, although they are connected at each extremity, the interspace being filled up by muscles. The radius, which is articulated with the carpus, turns upon the ulna, and carries consequently the hand with it in the motions of pronation and supination,—the former of which motions is much more frequent than the latter.

The *hand*, which is composed of the carpus, metacarpus, and phalanges, is continuous with the long axis of the arm. Its numerous bones and articulations admit of such a degree of motion, as to render it the most perfect prehensile organ; at the same time that it is enabled, from the quantity of elastic structure which enters into its composition, to obviate the effects of violence from concussion upon the other bones of the upper extremity.

The *wrist-joint*, which is produced by the articulation of the upper row of the carpus with the radius and inter-articular cartilage, also assists in deadening the shocks which the hand may receive

The *carpus* forms the upper boundary of the hand; and is not only rendered infinitely strong by the number of the bones, but also by their arrangement; for they are so placed as to form an arch, the concavity of which is towards the palm, while the convexity is directed backwards, to resist violence in the direction in which it is most exposed.

The *metacarpus* is composed of four bones, placed between the fingers and the carpus, and forms the palm of the hand, which is of a square form, but broader at its digital than at its carpal end, so that the metacarpal bones somewhat diverge inferiorly, and thus serve not only to enlarge this surface, but also to extend the range of motion of the fingers. The bones of the metacarpus are concave in the palm, and convex on the dorsum of the hand; they are separated from each other to lodge and give attachment to muscles, as well as to increase the prehensile surface of the hand.

The *fingers* are five in number, and enjoy both separately and collectively more motion than the other parts of the hand; and however perfect the organization of the carpus and metacarpus may be, still, without the faculty of motion, and that peculiar adaptation of parts which the fingers possess, the hand would yet have been but ill fitted for the numerous and important functions for which nature has intended it as a fit instrument to a rational being like man.

The *pelvis*, at the adult period of life, is composed of three large bones, the ossa innominata, and the sacrum; the os coccygis is rather to be considered as an appendix to the sacrum, than as a separate bone in the formation of this cavity. The bones of the pelvis are all so firmly connected, and their adjustment so perfect as to their mechanical disposition, as to be admirably constructed for the purposes of supporting the superincumbent weight of the trunk, for lodging and protecting the viscera within the cavity, and to form a fulcrum for the lower extremities to move on. These bones, in fact, form a double arch, which gives to them great additional strength, whilst the lower extremities may be considered as supporters to this arch.

The axis of the pelvis is not perpendicular to the central line of gravity, hence the viscera of the pelvis are infinitely better supported by the bones, and the whole weight of the body is thrown upon the lower extremities. The human subject, by this arrangement, is also enabled to support the erect position; while the expansion of the bones afford ample attachment for those muscles which are destined to maintain it.

In the sitting posture, the axis of the pelvis is so altered, that the central line of gravity falls upon the tuberosities of the ischia, upon which the whole weight of the body is then equipoised—a position which would have been impossible to man, had the sacrum continued in the same line with the spine; or, in other words, had the axis of the pelvis been perpendicular with the line of gravity of the body. In the descriptive anatomy of the pelvis, the cartilages and ligaments which serve to connect the bones have been noticed; which are not only destined to form the medium of connexion between them, but also to obviate the effects of concussion upon the spine and viscera which they contain.

The variation of size in the male and female pelvis, has already been alluded to: the lateral proportions in the female infinitely preponderating, to allow of the increase of size of the uterus during its impregnated state.

The greater proportionable size, length, and strength of the inferior extremities of the human species, when compared with those of inferior animals, proves, with the facts already stated of the form and position of the pelvis, that man alone was intended to support himself in the erect posture.

The *thigh-bone* we find articulated with the pelvis by its head, which forms a considerable portion of a sphere, being admitted into a deep cotyloid cavity, and being further connected with this cavity by a strong inter-articular ligament, rendering this articulation well fitted to bear the weight of the body. The weight is thence transmitted to the thigh-bone by its neck at an angle, which, together with the width of the pelvis, serves to separate the thigh-bones widely from each other, and thus leave sufficient space for the external organs of excretion and generation. From the point of attachment of the neck to the shaft, the thigh-bone is directed downwards with an obliquity, so as to bring its inferior extremity immediately under the pelvis towards the central line of gravity, so that the two femora approximate and form a firm base of support, as well as to render progressive motion both more secure and direct. The thigh-bone is remarkable for its projections, which not only serve to strengthen the bone, but also assist the action of muscles by altering the angle of their attachment. The anterior curvature of the femur tends also to increase its power of resistance.

The lower extremity of the os femoris is expanded into two protuberances or condyles, which form large articulatory surfaces for the tibia, and are so seperated behind as to admit the popliteal vessels and nerves between them, and thus offers them protection from injury.

From what has been said of the obliquity of the thigh-bones inwards, it is clear that the two condyles, which are intended to come in contact with the upper surface of the tibia on the same level, cannot be precisely of equal length, unless, indeed, the leg had a corresponding obliquity; we therefore find the internal condyle the longer of the two.

The *leg*, below the knee, is composed of two bones, which must necessarily give greater strength than the same substance in a single bone could have done: they are furnished with spines or edges, which render them better capable to resist injury. The two bones of the leg are separated from each other, like the bones of the fore-arm, and the interspace filled up by ligament; but they differ essentially from the bones of the fore-arm, which admit of a rotatory motion upon each other, while the bones of the leg are much more firmly connected, to offer a more perfect support to the body.

The articulation of the leg with the thigh, assisted by the patella, forms the *knee-joint*, which may be considered as the most complicated in the body, in consequence of the numerous and strong ligaments which surround it. It has been mentioned that this joint, when a little bent, admits of a slight degree of rotatory motion; and this is performed by the internal condyle turning on its own axis on the inner articular face of the tibia, while the external condyle moves backward and forwards; but the rotation is allowed to a greater degree outwards than inwards, from the mode of attachment of the crucial ligaments.

The outward twisting of the leg is of use in progressive motion, by allowing the foot to form a broader base for support; whilst, at the same time, it is favourable to the action of crossing the legs. The obliquity of the knee-joint inwards serves to increase the elasticity of the lower extremity, and consequently to diminish the effects of concussion, by throwing the weight from the perpendicular line of the femur. It is further useful in leaping, by producing the force caused by the sudden extension of the joints acting nearer to the centre of gravity.

The *foot*, which is composed of the tarsus, metatarsus, and phalanges, forms a beautifully constructed elastic arch, sufficiently strong to support the whole weight of the body, and at the same time sufficiently pliable to prevent its sustaining injury from concussion under the most violent exertions. These ends are effected, not only by the various bones of the foot forming numerous articulations, and these being furnished with elastic cartilages; but also by the foot itself forming a longitudinal arch, reaching from the posterior extremity of the os calcis, to the anterior extremity of the metatarsal bones. The most convex part of this arch is situated at the upper part or dorsum of the foot, and is formed by the astragalus, which receives the weight of the body through its articulation with the tibia and fibula; so that the astragalus may be considered as the key-stone to the arch, rendered better able to bear the great pressure to which it is subjected, by resting on a fibro-cartilaginous structure; which structure allows it to sink or rise as subjected to, or relieved from pressure. A second longitudinal arch is formed from the extremity of the metatarsus to the extremity of the toes, which renders them both stronger and somewhat prehensile, and assists much in progressive motion. A third arch is formed in the sole of the foot, besides the two already described, which reaches from side to side, and serves not only to assist in giving elasticity and strength, but also to protect the soft parts, which might otherwise be injured from pressure. From these remarks, it must be considered that the foot possesses a considerable degree of mobility; but it must also be remembered, that it exerts this mobility only during motion; for when we are standing still in the erect posture, or when the weight of the body bears directly and perpendicularly on the astragalus, all the parts of the foot are so closely pressed together, as to render the whole an immoveable and unyielding structure. The projection of the heel-bone, or os calcis, passes backwards considerably posterior to the articulation of the bones of the leg with the foot, so that in progressive motion the part of the foot which first comes to the ground is not placed immediately underneath, and perpendicular to the tibia and fibula; and thus the elasticity of the foot is called into action to prevent concussion and jolting. The lengthening backwards of the os calcis, also affords additional power to the extensor muscles of the ancle-joint.

The *ancle-joint*, which is formed by the union of the foot with the bones of the leg, admits of motion in such directions as assist in the performance of the moveable capabilities of the foot; and again, by projecting portions of bone, render the foot firmly fixed when its stability and strength are most required: for instance, in progressive motion, when the foot is pointed downwards or extended, then the astragalus is capable of lateral motion between the malleoli, so that the foot may be directed at will; while, on the contrary, when the whole of the body is thrown upon one extremity, and consequently perpendicular to the foot, the ancle-joint remains motionless, and a firm base of support is produced.

In fact, if we examine the means which are employed in the formation of the human skeleton, for the purposes and functions for which it was intended, we can but be struck with admiration and awe, at the wonderful designs nature has manifested in the performance; and yet we should observe, that to provide against every possible accident and injury was not the intention of the Creator, but rather that the prerogative of man, his judgment and his power of reason, should not only assist him in the proper applications of its various functions, but also be continually called in aid to avoid the injuries to which it is so constantly exposed. It has been ordained, indeed, that we should be the subjects of disease and decay.