

## **Osteological memoirs. No. I. The clavicle / by John Struthers.**

### **Contributors**

Struthers, John, 1823-1899.  
Royal College of Surgeons of England

### **Publication/Creation**

Edinburgh : Sutherland and Knox, 1855.

### **Persistent URL**

<https://wellcomecollection.org/works/ajg64d96>

### **Provider**

Royal College of Surgeons

### **License and attribution**

This material has been provided by This material has been provided by The Royal College of Surgeons of England. The original may be consulted at The Royal College of Surgeons of England. where the originals may be consulted. This work has been identified as being free of known restrictions under copyright law, including all related and neighbouring rights and is being made available under the Creative Commons, Public Domain Mark.

You can copy, modify, distribute and perform the work, even for commercial purposes, without asking permission.



Wellcome Collection  
183 Euston Road  
London NW1 2BE UK  
T +44 (0)20 7611 8722  
E [library@wellcomecollection.org](mailto:library@wellcomecollection.org)  
<https://wellcomecollection.org>

3

OSTEOLOGICAL MEMOIRS.

No. I.

THE CLAVICLE.

BY

JOHN STRUTHERS, M.D.,

FELLOW OF THE ROYAL COLLEGE OF SURGEONS OF EDINBURGH,

LECTURER ON ANATOMY.

EDINBURGH:

SUTHERLAND AND KNOX, 60, SOUTH BRIDGE.

LONDON: SIMPKIN, MARSHALL, AND CO.

1855.

MURRAY AND GIBB, PRINTERS, EDINBURGH.

## P R E F A C E.

---

THE following memoir is the first of an intended series. Each memoir, however, will be complete in itself.

The bones will be considered also in their relation to the muscles and joints; a study which invests them with a new interest, and without which, indeed, much of the anatomy and philosophy of their various parts must remain unrecognised.

The descriptions are entirely from Nature. They were written after the examination of many specimens and dissections, and represent the usual or typical anatomy. The measurements given also represent the average of many. The habit of making careful measurements is a valuable one to the anatomist; it gives an exactness and finish to our knowledge, whether of large things or small, and enables us to use proportion in the recollection of facts or the discovery of principles.

The reader, in search of knowledge, will not object to the little repetitions which must occasionally occur, or to the plainness of the style; and I must request that he will take the bone in his hand, or indeed, have several specimens of it before him, so that he may follow me in the process by which the results are arrived at. He will thus see what the difficulties have been, and in the end will understand the bone.

Descriptive anatomy seems to be regarded by many as an exhausted science, but is far from being so. What science is, or can be so, when nature is the study and man the student? As Bacon has well said, "They who confidently or magisterially pronounce of nature, as of a thing already discovered, have

highly injured philosophy and the sciences." Each new discovery, or method, or addition, opens the way to farther research and thought, and each new and greater application brings out new facts and principles, which gradually unfold themselves under the patient exercise of observation and thought, the combined use of the bodily and mental eye. I do not write thus of anatomy from enthusiasm; ten years in a dissecting room and at the lecture table afford ample time and occasion for mere enthusiasm to cool; but the longer I teach it, and the more I look into it, the more do I find it a rich field inviting new and farther investigation.

These Memoirs I offer to my fellow-anatomists as mere fragments of Osteology, from among the fruits of study in leisure hours, conscious of their many imperfections; asking them, in the words of a well known writer, to "remember that the only merit to which I lay claim is that of patient research,—a merit in which whoever wills may rival or surpass me; and that this humble faculty of patience, when rightly directed, may lead to more extraordinary developments of idea than even genius itself. What I had been slowly deciphering were the ideas of God as developed in the mechanism and framework of his creatures."

EDINBURGH, JULY 1855.

# No. I.—THE CLAVICLE.

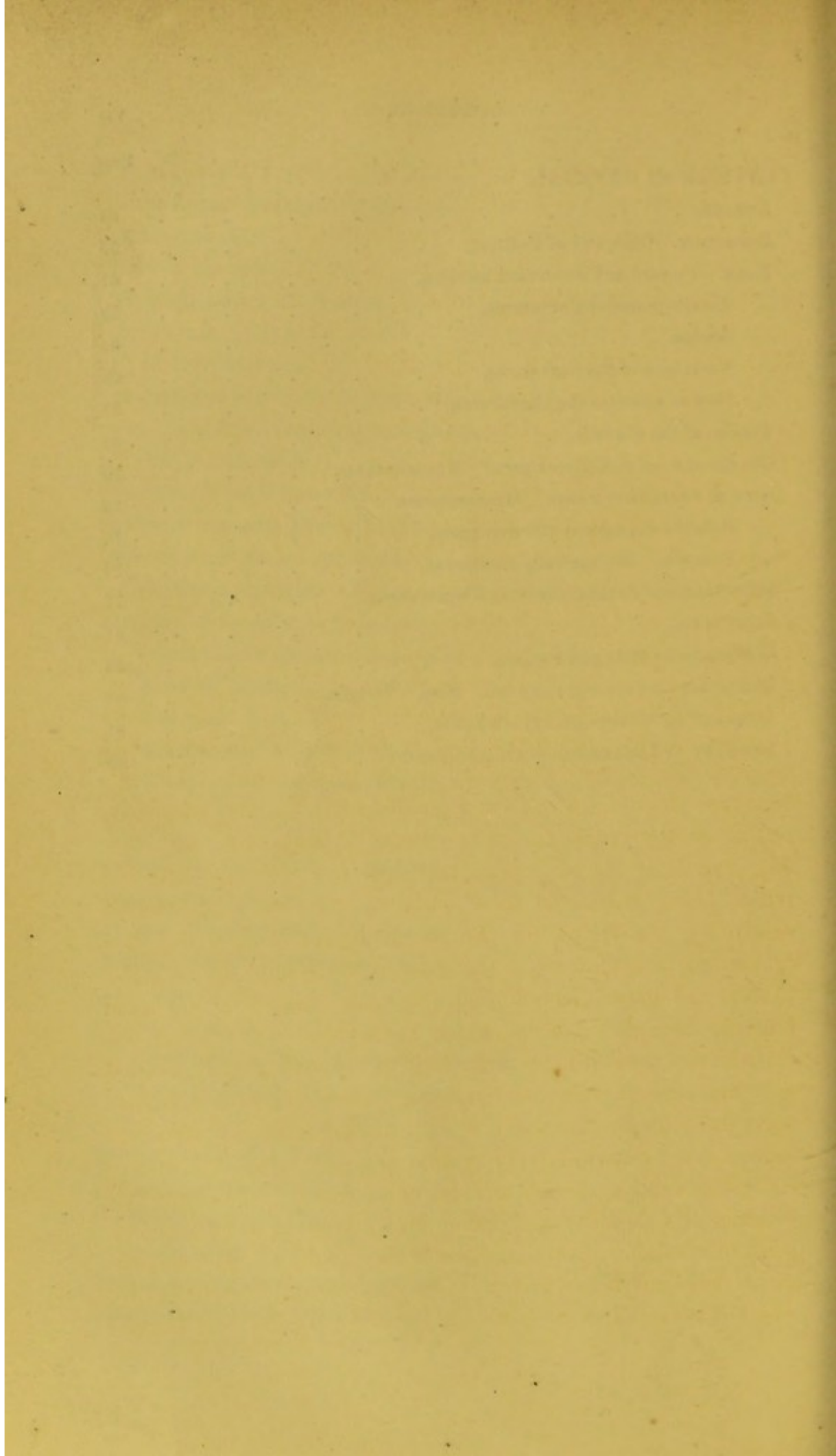
## CONTENTS.

	Page
Clavicle in general, . . . . .	1
ACROMIAL EXTREMITY, . . . . .	3
ACROMIAL FACET, . . . . .	4
NON-ARTICULAR PARTS of acromial end, . . . . .	7
<i>Ligamentous Impression</i> , . . . . .	7
BODY OR SHAFT, . . . . .	8
(a) <i>Outer Third or Tabular Portion</i> , . . . . .	9
ANTERIOR AND POSTERIOR BORDERS, . . . . .	10
SUPERIOR SURFACE, . . . . .	11
Attachment of Deltoid and Trapezius Muscles, . . . . .	11
<i>Deltoid Impression—Impression for Trapezius</i> , . . . . .	12
<i>Subcutaneous Space</i> , . . . . .	13
INFERIOR SURFACE.	
Attachment of Conoid and Trapezoid Ligaments, . . . . .	14
<i>Conoid Tubercle</i> , . . . . .	14
<i>Trapezoid Impression</i> , . . . . .	15
<i>Unoccupied Spaces</i> , . . . . .	16



## CLAVICLE IN GENERAL.

LENGTH, . . . . .	58
DIRECTION. Obliquity of Position, . . . . .	59
FORM. Upward and downward bending, . . . . .	61
Antero-posterior Curvatures, . . . . .	62
Arches, . . . . .	64
Variations of the Curvatures, . . . . .	65
How to estimate the Curvatures, . . . . .	67
Torsion of the Clavicle, . . . . .	68
Change of form at different parts. Measurements, . . . . .	70
SIZE AT DIFFERENT PARTS. Measurements, . . . . .	72
Relative strength at different parts, . . . . .	74
Fracture. Mechanically considered, . . . . .	74
PRINCIPLES OF CONSTRUCTION AND MECHANISM, . . . . .	77
STRUCTURE, . . . . .	81
Differences in Male and Female, . . . . .	84
Differences between right and left. Size. Weight, . . . . .	85
SUMMARY OF MUSCULAR ATTACHMENTS, . . . . .	87
SUMMARY OF LIGAMENTOUS ATTACHMENTS, . . . . .	89



## THE CLAVICLE.

---

THE *shoulder* is composed of two bones, the scapula and clavicle. It is placed upon the upper part of the side of the chest, and connects the superior extremity proper to the trunk. The two bones are placed so as to form a pointed arch, the base internally, resting on the trunk, the apex externally, supporting the arm. The scapula is placed behind, and does not articulate with the trunk, being connected to it only by muscles. It presents externally, the socket for the shoulder-joint, and is flat and broad for the attachment of the muscles which bind the humerus to it at the joint. In addition, the spine behind is prolonged into the acromion process, which meets the outer end of the clavicle, and forms the posterior limb of the arch already alluded to. The clavicle forms the anterior limb of the arch. It supports the scapula externally, by articulating with the acromion process; and rests internally against the sternum. The articulation between the clavicle and sternum forms the only connexion between the shoulder and trunk, and serves as a fulcrum, or point of resistance, in the motions of the shoulder. The clavicle serves two purposes; first, it gives attachment to muscles by which it is moved, or to which it forms a fixed point of action;

and, second, it supports the shoulders, and prevents them from falling forwards, by being planted in, like a beam or stay, between the acromion and the sternum, thus keeping the shoulders separate. This is better understood by a glance at its comparative anatomy. In most quadrupeds the clavicle is entirely wanting, the shoulder being formed by the scapula alone, and connected to the trunk by muscles only. In some, as in the cat tribe, it is present as a separate bone, intimately connected to certain muscles which pull it up and down, and to which it gives a fixed point of action, like the hyoid bone in man, when the opposite class of muscles have acted. It has however no connexion with the sternum or scapula, being short and farther represented only by a tendinous intersection in the muscles. But in those in which the fore-limbs require to be used more or less as arms, the clavicle is developed so as to serve also the second of the purposes above mentioned. The shoulders are now supported by clavicles, and thrown outwards, so as to afford that freedom of the fore limbs, which was not required and would have been injurious in those animals in which the fore limbs, like the hind ones, are used merely as organs of support and locomotion.

Taking the widest view of the comparative anatomy of the scapula and clavicle, they may be regarded as portions of the occipital bone and atlas, thrown down from that region to the upper part of the chest, where, in man and the higher vertebrate classes, it is more convenient to have the upper extremities planted. But we commonly and conveniently speak of them as forming the first division of the superior extremity, to which they practically belong. In man, the two bones are constructed and placed with the double purpose of forming, by their arch, a secure foundation for the arm, and of attaching muscles for its motion,—some of which also assist in the motions of the chest and head.

The *clavicle* presents a shaft or body, and two extremities. In character, or form, as well as internal structure, it is intermediate between the flat bones, such as the ribs, and the long cylindrical bones of the limbs. Unlike the latter, it is not concerned in

joints where one bone receives or is received into the other, and has therefore less pronounced extremities, which present merely articular facets, looking to the bones with which they articulate. The external extremity presents almost no enlargement, and articulates by an oval facet with the acromion process of the scapula, forming the acromio-clavicular articulation. The internal extremity presents an irregularly triangular enlargement, to which several strong ligaments are attached, and an articular face by which it articulates with the shallow semilunar notch in the sternum, and in part also with the cartilage of the first rib, forming the sterno-clavicular articulation. The body or shaft, therefore, embraces nearly the whole length of the bone. It has a double curve in the antero-posterior direction, giving it the form of an elongated *f*. The internal curve is convex forwards, and occupies about the two inner thirds; the external is convex backwards, and belongs to the outer third.

The length, position, form, curvatures, and varieties of the clavicle will be afterwards considered; but it is well to premise here, in general terms, that the usual length, measuring straight from end to end, is from  $5\frac{1}{2}$  to 6 inches; and that there are great varieties in the curvatures and in the thickness and markings of this bone. Some specimens are much more slender than others, also less curved, smoother, or less marked by the muscular and ligamentous attachments, and also shorter. These are generally from female skeletons, and are not so well suited for the first study of the characters of this bone. A well-marked specimen should be selected, and it will be advantageous to study from several specimens presenting the characters in different degrees.

#### EXTERNAL OR ACROMIAL EXTREMITY.

The outer end presents the smooth oval facet for articulation with the acromion, and the neighbouring non-articular part should also be comprehended under this head. The latter includes the more or less acute anterior angle, the much rounded posterior angle, and the last quarter or half inch of the upper

surface, which is somewhat enlarged or raised and also rough for ligamentous attachment. The posterior part of the external extremity varies much in different specimens, the posterior angle appearing sometimes at or close to the posterior end of the articular facet, and sometimes nearly an inch behind this. In the former, the extremity appears square cut and occupied in its whole length by the acromial facet; in the latter, it appears much rounded and the facet seems to occupy only the anterior half of the extremity. The true posterior angle is, however, immediately behind the facet, and the greater or less development of it gives the outer end more or less of the square cut appearance. The rounded angle from half an inch to an inch behind this, is the commencement of the rough elevation for the attachment of the superior ligament, and is the most prominent part of the posterior border of the bone.

**ACROMIAL FACET.**—We have to consider its position, form, size, direction, and the nature of the surface.

The *position* has just been defined as occupying the whole extent of the true external extremity. The occasional appearance of the facet being situated upon the anterior part only, is due to the appearance of the extremity extending farther back than it truly does. In a well-marked specimen the true posterior angle is prominent, the extremity square cut, and the facet occupies the whole length from angle to angle.

In *form*, it is nearer an oval than any other, but the lower edge is straight, so that the true form is that of half an oval, the lower half being deficient. The lower edge is usually straight or nearly so; in ill-marked specimens, or again, in some very strongly marked ones, in which the facet is large, it may be somewhat convex downwards. The upper edge is convex upwards, reaching to the level of the upper surface. The anterior and posterior ends are rounded or narrow according to the greater or less depth of the surface. If there is any difference between them, the anterior is the broader or most abrupt, especially in ill-marked specimens, in which the posterior angle is less prominent.

The *size* varies very much. In slender specimens it is much smaller both in length and depth, and often on the dried bones very ill-defined; but in the strong specimens it is a large and well-defined surface. In the former, the length is usually half an inch, the greatest depth a third or fourth. In the strongest specimens, the length is one inch, the depth half an inch. My list of measurements, made both from recent and dried specimens, shows all grades, between these extremes, still keeping generally, but not invariably, the proportion that the depth at the middle is half the length. The average length is two-thirds, the average depth one-third of an inch. The facet occupies the whole of the external extremity proper, reaching, in front, quite close to the anterior angle, behind, to the true posterior but less defined angle; above, to the level, or almost to the level, of the rough part of the upper surface; and below, fully to the level of the lower surface, sometimes even forming a slightly projecting lip.

The *surface* is usually neither convex nor concave, but flat or plane, in both directions. It is distinctly so in well-marked specimens, but when the facet is small it is occasionally somewhat convex from before backwards, especially behind; vertically, however, it has very seldom any degree of convexity. In the recent and natural state, it is commonly said to be smoothly covered with articular cartilage, but I have always found it more or less spongy, or also irregular, as if covered by a layer of fibro-cartilage, instead of ordinary articular cartilage. This spongy cartilage is about  $\frac{1}{10}$  or  $\frac{1}{12}$  inch in thickness; it may cover the articular surface uniformly, forming an even though still spongy surface, or it may be uneven or tuberculated, leaving some parts of the articular surface as if covered by a thin periosteum only. In the bones from which the cartilage has been separated by maceration, the facet is usually formed by a smooth articular lamina, thinner and less polished than that which usually supports articular cartilage; but often instead of a smooth lamina, the surface is irregular and perforated by numerous larger and smaller apertures, and this more especially in the largest and most muscular speci-

mens. This condition appears to be independent of disease or age.

All around the joint, but especially above, there are fatty or synovial fringes growing from the synovial membrane, which either project into the joint or are so placed that they may do so. It must be this structure hanging into the joint from above, as a soft wedge, which has been described as an imperfect fibro-cartilage. I have never met with an inter-articular fibro-cartilage, perfect or imperfect, at this joint.

The *direction* of the surface is to be considered antero-posteriorly and vertically. Antero-posteriorly, it is cut nearly at right angles to the axis of the outer part of the shaft, and, therefore, in a direction from behind forwards and inwards. It therefore looks outwards and forwards, having the same direction as the outer part of the shaft. In examining a series of clavicles laid horizontally on the table, it is seen that the facet, directed outwards and forwards, has much more of the outward than the forward direction, and the latter is still less when we place the bone in its natural oblique position, in which the outer end is thrown an inch and a half or two inches farther back than the sternal end. Even then, however, except in one or two of my specimens in which it looks straight out, the surface continues to have a considerable obliquity forwards. This is the direction taken by the fibres of the strong ligament which covers the joint; they have a marked direction forwards as well as outwards.

Vertically, the facet is cut, not at right angles to the surface, but obliquely downwards and inwards. It thus faces obliquely downwards and outwards, so as partially to rest upon the facet of the acromion, which has a corresponding obliquity upwards. This is easily seen in taking different views of the bone; when lying on its lower surface, the facet is not visible, but is entirely so when the bone is turned round and seen from below. This obliquity is sometimes inconsiderable, and I have seen the surface cut quite vertically; but usually, and always in well-marked specimens, the obliquity is strongly marked. This is a point of some importance in connexion with the mechanism of the joint. The clavicle resting obliquely upon

the acromion, will naturally tend to slip over, not under it; or rather, as the clavicle is the more fixed bone, the acromion will tend to slip in below the clavicle, constituting, what is called dislocation of the clavicle over the acromion. In relaxation of the ligaments this is partial, and becomes complete when the ligaments which bind the clavicle to the coracoid and acromion processes are torn.

The direction, then, of the articular facet, is chiefly outwards and somewhat forwards; and also obliquely downwards, so as to rest obliquely upon the inner edge of the acromion.

**NON-ARTICULAR PARTS OF EXTERNAL EXTREMITY.**—These are the anterior and posterior angles and the part immediately internal to the articular facet, distinguished from the shaft proper by roughness or porosity and usually by a slight enlargement.

The *anterior angle* is formed by the meeting of the articular facet and the anterior border. It is almost invariably very well defined, and is usually an acute angle, though occasionally a right angle or even a little obtuse. It is the most anterior or prominent part near the outer end of the clavicle. It is rough for about  $\frac{1}{4}$  or  $\frac{1}{3}$  inch along the anterior border, for the attachment of the anterior part of the superior ligament of the joint.

The *posterior angle* proper, is at the posterior end of the articular facet. It is sometimes a right angle slightly blunted, but is usually more or less obtuse. It is more distinct when seen from below, from the greater flatness of the inferior surface; whilst the anterior angle is most distinct when seen from above.

*Ligamentous Impression.*—Immediately internal to the acromial facet, there is on the upper surface, a rough part for the attachment of the superior acromio-clavicular ligament. It is distinguished from the upper surface proper by texture and colour, also usually by its elevation. It is either rough, or minutely porous, or may present both of these conditions. Opposite the anterior part of the upper surface it is  $\frac{1}{4}$  to  $\frac{1}{3}$  inch in breadth; opposite the back part, along and in front of the posterior border, it extends for  $\frac{3}{4}$  or even for an entire inch inwards from the articular facet. It thus increases in breadth

from before backwards, the posterior part reaching much farther upon the clavicle than the anterior. This posterior part, usually sloping, or convex backwards and upwards, becomes gradually narrower inwards, and terminates at the most prominent part of the posterior border of the shaft, nearly an inch from the true posterior angle.

To this impression is attached the superior acromio-clavicular ligament. This ligament is nearly an inch in breadth, extends very obliquely backwards and inwards from the acromion, and covers and is attached to that part of the clavicle above described as the ligamentous impression. The ligament is a very strong one, requiring this extent of surface for the attachment of its fibres; and the obliquity of its direction seems to accord with its running much more extensively upon the clavicle behind than before.

There is no corresponding roughness or impression on the under surface. The comparatively weak fibres which constitute the inferior ligament are attached close to the lower margin of the facet, and leave about  $\frac{1}{4}$  inch of unoccupied bone between them and the most external part of the trapezoid ligament. The lower edge of the facet sometimes projects a little downwards as a rough lip. The inferior acromio-clavicular ligament is very weak compared to the superior, and at or behind the middle of the facet, there is very little ligament. But at the fore and back parts there is a stronger portion, each about  $\frac{1}{3}$  inch in breadth. The posterior of these comes rather from the upper surface of the acromion, and twists in below to its clavicular insertion; the anterior arises from the under surface of the acromion, and is rendered continuous with the superior ligament by the fibres which are attached to the outer  $\frac{1}{3}$  inch of the anterior border of the clavicle, and lie exactly in front of the joint.

#### BODY OR SHAFT.

The outer and inner portions of the body of the clavicle differ so much in form and muscular relations, that it is best to describe

them separately. The *outer portion* embraces the outer third; it is flattened from above downwards, presenting two surfaces, upper and under, and two borders, anterior and posterior; it is curved, with the concavity forwards; and is modelled for the attachment of the trapezius and deltoid muscles, and for articular and ligamentous connexion to the acromion and coracoid processes of the scapula. The *inner portion*, embracing the two inner thirds, is curved in the opposite direction; is thicker looking and is somewhat irregular in its borders and surfaces, being either irregularly rounded, or three sided, or when well marked, four sided; and is modelled for the attachment of the pectoralis major, sterno-mastoid, and subclavius muscles, and for the support of the large internal extremity of the bone.

There is no abrupt limit between these, as the flat portion passes gradually into the more rounded portion, but it is almost exactly at the union of the middle and outer thirds that the distinctive characters and muscular relations of the outer portion commence. The outer third may be conveniently referred to as the *external or tabular portion*, and the inner two-thirds as the *internal or cylindrical portion* of the clavicle.

#### *External or Tabular Portion.*

The outer third is flattened from above downwards, so as to present two surfaces and two borders. The surfaces are superior and inferior; the borders, anterior and posterior. The borders are often referred to as superior and inferior in descriptions of the trapezius and deltoid muscles, but their true position is posterior and anterior. Naturally, the surfaces of this part are nearly horizontal. The superior surface has some obliquity forwards, so that, the eye being on the same level as the bone, the whole surface can be seen in a front view, but none of it from behind. This obliquity, however, is but slight, and is much less than that which usually appears when the bone lies on the table with this surface exposed. The inferior surface has less of this obliquity, if indeed it is not altogether horizontal; which is due to the greater thickness below the posterior border.

**ANTERIOR BORDER.**—The anterior border is concave, thin and rough. It forms the lower or anterior limit of the deltoid impression on the upper surface, the deepest fibres of the muscle arising from the border proper. The roughness is greater internally than near the acromial extremity; and, at about  $1\frac{1}{2}$  inch from the latter, it is sometimes so great as to form a distinct tubercle (deltoid tubercle), sharp and horizontally elongated, which is occasionally easily felt in the living body.

**POSTERIOR BORDER.**—The posterior border is convex. Beginning at the posterior angle or end of the acromial facet, nearly the first inch forms part of the ligamentous impression already described for the attachment of the superior acromio-clavicular ligament. This part is directed backwards; and the border by now turning forwards, forms the rounded angle already noticed as nearly an inch behind the acromial facet. The border now passes inwards as the exact posterior edge of the superior surface, and for  $1\frac{1}{2}$  to 2 inches is somewhat rough, for the attachment of the deeper fibres of the trapezius muscle, but is not nearly so sharp and rough as the anterior border.

Below the posterior border, as above defined, there is a narrow surface, not usually included with either the upper or under surfaces of the flat part of the bone. It might be reckoned as a very broad posterior border, but is properly a part of the deep surface of the clavicle, thrown backwards by the projection of the tubercle for the attachment of the conoid ligament, and the lines on each side of the tubercle. It will be afterwards referred to as the narrow outer part of the posterior or cervical surface of the clavicle. It gives attachment to the deepest fibres of the trapezius muscle, which pass below the exact edge or true posterior border, as far down as to meet the fibres of the conoid ligament at the base of the tubercle, or even farther than this upon the back of the ligament itself; and external to this, they reach quite down to the posterior limit of the inferior surface proper, appearing almost as if they passed a little way upon the inferior surface.

**SUPERIOR SURFACE.**—The superior surface is flat, but presents certain characteristic irregularities. It is deeply marked in front for the deltoid muscle, and behind for the trapezius, while the middle part is subcutaneous; and, externally, it presents the beginning of the rough ligamentous elevation at the acromial extremity. This surface can be called subcutaneous only in the sense that it is the surface nearest the skin, for the greater part of it is covered by the muscles. The deltoid and trapezius muscles do not merely take hold of the borders but extend upon the upper surface, leaving only a narrow part in the centre properly subcutaneous. The breadth of the upper surface varies considerably in slender and strong specimens. It increases from within outwards, and is broadest about half an inch to an inch internal to the acromial extremity, opposite the rounded angle on the posterior border. Here, in strongly marked specimens, the breadth may exceed an inch. On an average, the breadth of this surface is, at its union with the internal portion, scarcely  $\frac{1}{2}$  an inch; at its middle  $\frac{3}{4}$ ; and at the broadest part one inch; the bone again narrowing somewhat to the facet, the average breadth or length of which we saw to be  $\frac{2}{3}$  of an inch.

This surface may be divided, from before backwards into three parts, the anterior for the deltoid muscle, the posterior for the trapezius muscle, and the middle or subcutaneous portion. The attachments of these two muscles begin internally nearly opposite each other, about two inches from the acromial extremity of the bone; but, as the trapezius has the convexity and the deltoid the concavity of the curve, the attachment of the trapezius is absolutely about half an inch longer than that of the deltoid, the latter being usually  $1\frac{3}{4}$ , the former  $2\frac{1}{2}$  inches. Their most internal parts are attached more to the borders, leaving most of the surface uncovered; they then encroach gradually upon the upper surface, approaching each other more or less in different cases. The deeper fibres of the deltoid are attached along the border as far out as near the anterior angle of the facet, but the trapezius at the outer part of the posterior border, from the rounded angle to the facet, is attached to the ligament rather than directly to the bone, as the last half inch of the surface, and the last inch

of the posterior border, are occupied by the superior acromio-clavicular ligament. The most external fibres of both muscles, but especially of the trapezius, are aponeurotic and much mixed up with those of the ligament.

The bone presents markings corresponding to this anatomy of the soft parts. The *deltoid impression* is the best marked. It is an excavation with rough margins. Beginning near the junction of the middle and external thirds, by a pointed angle, it extends outwards, becomes broader, and is bounded by an upper and lower lip or edge. The lower lip is identical with the anterior border of the bone, and renders that border rough on its upper aspect. This roughness is greatest near the inner end of the impression, and here it is occasionally developed into the process or tubercle already mentioned (*deltoid tubercle*), which is usually narrow and elongated horizontally, though sometimes thicker and reaching to the upper lip of the impression; and sometimes instead of a tubercle there is a rough excavation. From this tubercle, or very rough part, a more tendinous portion of the deltoid arises. The roughness is much less marked in the external half of the impression. The upper lip, which may be called the *deltoid line*, curves upwards upon the upper surface, and again approaches the lower near the outer end. The last part of the anterior border for about  $\frac{1}{3}$  inch, belongs to the anterior part of the acromio-clavicular ligament. The surface of the deltoid impression is concave in both directions, smooth looking compared with the edges, and faces obliquely upwards and forwards. This oblique cutting of the anterior part of the upper surface renders the thickness of the outer third of the clavicle much less in front than behind, and gives the sharpness to the anterior border. The deltoid impression is broadest in the middle. Here it may be  $\frac{1}{3}$  inch in breadth, but is usually about  $\frac{1}{4}$  inch, and occupies about the anterior third of the upper surface. This description applies only to muscular specimens. In slender clavicles, the deltoid impression may appear merely as a more or less broad roughness on the superior aspect of the anterior border, with little or no separation into lips.

The *impression for the trapezius* is very obscurely marked, and

it is only on a very rough bone that it appears as a defined impression. The roughness occupies the posterior border as far in as opposite the inner end of the deltoid impression, or nearly so; and, in front of this, about the posterior third of the upper surface, reaching more upon the surface the farther out. It may appear as a depression bounded in front by a raised line; but usually there is no more than a roughness over the extent above defined, without any distinct boundary line in front.

The *subcutaneous space* varies with the extent of the muscles. It may be  $\frac{1}{4}$  inch in breadth, and grooved, from lying between two raised lines bounding the impressions for the deltoid and trapezius; or it may scarcely exist, as the muscles sometimes meet in the middle and thus conceal the whole of the upper surface. Sometimes the one sometimes the other muscle covers most of the breadth; I have seen the deltoid  $\frac{1}{3}$  inch and the trapezius  $\frac{1}{6}$ , and again these proportions exactly reversed; in others, each muscle  $\frac{1}{3}$ , and the unoccupied space  $\frac{1}{4}$  inch. Most internally they do not at first reach over the bone, for the first  $\frac{1}{2}$  or  $\frac{3}{4}$  inch, but the last  $1\frac{1}{2}$  inch of the clavicle always is more or less and may be entirely concealed by especially the aponeurotic fibres of these muscles, and in its last half inch by the ligament. These aponeurotic fibres, however, do not, along the centre or middle part, form a soft covering, but adhere to the bone like a thick periosteum, so that the muscles do not cover it in the same sense as they do the anterior and posterior parts. The space between the muscles rather increases in breadth outwards in the last half inch. This, together with the flatness of its form explains why the outer third of the clavicle is so difficult to trace with the finger compared with the inner two-thirds, in the examination especially of the living shoulder.

**INFERIOR SURFACE.**—The inferior surface presents the same length and breadth as the superior, and like it is also flattened. It lies above the coracoid process of the scapula, and is connected to it by a very strong double ligament, the impression for the attachment of which is the principal point of importance on this surface. This *ligamentous impression* is seen as a very rough

crescentic mark extending obliquely across the surface, from the posterior to the anterior border, beginning at or below the posterior border, about two inches from the extremity, and terminating at the anterior border, about half an inch from the extremity.

The *coraco-clavicular ligament* consists of two parts, the conoid and trapezoid, meeting behind so as to form one continuous ligament; but, as it is customary and useful to consider them separately, I shall consider the exact attachment of each to the clavicle, and it will be found that though there is one continuous mark, the part belonging to each is well indicated on the bone. The part for the conoid ligament is posterior and internal, and is a blunt tubercle or eminence (conoid tubercle); that for the trapezoid reaches outwards and forwards from the tubercle, and is, though sometimes an elevation, usually a broad rough mark or impression (trapezoid impression). The two together form the coraco-clavicular ligamentous impression, or crescentic mark.

The following is the anatomy of the insertion of the ligament. The *conoid* portion has an insertion from  $\frac{3}{4}$  inch to an inch in length, horizontally along the posterior part of the under surface; and the most internal part of the insertion is two inches from the middle of the outer end of the bone. The *trapezoid* has a similar length of insertion; curving obliquely forwards and outwards, the most external part is  $\frac{1}{2}$  or  $\frac{1}{3}$  inch from the outer end of the bone, and reaches forwards to the anterior border. The insertion has also considerable breadth, increasing towards the outer end, where it presents a termination half an inch in breadth, either rounded or parallel to the anterior part of the lower edge of the acromial facet; a breadth of attachment which it owes not to the actual thickness of the ligament, but to its outward direction, so that the fibres run very obliquely upon the bone. These proportions were taken from dissections of full-sized specimens, and will enable us now to understand the markings on the bone.

*Conoid tubercle.*—This tubercle is best seen from behind. It is a broad ridge, nearly an inch in length transversely, and projecting down at the middle, so as to form an elongated tubercle, situated on the back part of the surface. Its backward position

is such that it appears to project down from the posterior border, thus making or increasing the narrow third surface already alluded to, as situated below the posterior border. In slender specimens it is not quite so far back as the posterior border, but in well-marked specimens it usually projects a little behind the level of the border, running obliquely backwards as well as downwards, and, in some, forms a considerable prominence at this part of the external curve of the bone. In breadth, or antero-posteriorly, it is  $\frac{1}{4}$  to  $\frac{1}{3}$  inch, and usually occupies about the posterior third of the surface. The anterior half or more, between it and the anterior border is smooth and concave, and is occupied by the outer end of the subclavius muscle. Transversely, the summit is usually  $1\frac{1}{2}$  inch from the middle of the outer end of the bone, the most internal part of its base being two inches. In specimens under the average length, the latter measurement may be  $\frac{1}{4}$  inch less. The whole length of the base of the tubercle is  $\frac{3}{4}$  inch to an inch, being somewhat curved on itself, the convexity backwards. The outer end becomes continuous in front with the inner end of the trapezoid impression, at about an inch from the external extremity of the bone.

The tubercle is rough below and also behind, the extreme inward limit of the base being indicated by the commencing roughness. The more projecting central part gives attachment to the centre of the conoid ligament, which is very thick for about  $\frac{1}{4}$  inch, and sends some of its fibres up on the back of the tubercle; and, from this, thinner parts of the ligament reach out on each side, to the inner and outer ridge like ends of the base of the tubercle.

*Trapezoid impression.*—This rough mark begins at the outer and fore part of the conoid tubercle, crosses the surface obliquely outwards and forwards, and terminates close to the anterior border,  $\frac{1}{3}$  to  $\frac{1}{2}$  inch from the outer end of the bone. It is usually  $\frac{3}{4}$  inch in length, or sometimes a little more by extending inwards in front of the outer end of the conoid mark, with which, however, it is usually continuous. Its oblique course across the surface enables it to have a greater length than would be otherwise compatible with leaving an unoccupied space of  $\frac{1}{2}$  or  $\frac{1}{3}$  inch

between its outer end and the acromial facet. It presents various appearances; sometimes it is a broad rough ridge, with a prominence almost equal to that of the conoid tubercle, and becoming more prominent at its outer and fore part; but more frequently it is merely a broad rough mark, either very slightly raised, or not unfrequently depressed. Its form is that of an elongated oval,  $\frac{3}{4}$  inch to an inch in length, and  $\frac{1}{3}$  to  $\frac{1}{2}$  inch in breadth. The posterior and inner end is more or less confluent with the conoid tubercle, and is behind the middle of the surface; the anterior or outer end comes quite close to the anterior border of the bone, is rounded and half an inch in breadth, so that it lies opposite more than the anterior half of the acromial facet, and is usually from  $\frac{1}{3}$  to  $\frac{1}{2}$  an inch from it.

I have been thus particular in describing the exact marks of the attachment of the two parts of the coraco-clavicular ligament, on account of its importance in relation to fractures through the outer third of the clavicle. Practically considered, the two parts have one continuous insertion, and the conoid tubercle and trapezoid mark form one continuous *ligamentous impression*. It is situated on the outer two inches or outer third of the bone excepting the last half inch; is about two inches or  $1\frac{3}{4}$  in length, curved, but  $1\frac{1}{2}$  in a straight line; and has an average breadth of  $\frac{1}{3}$  inch. It is somewhat crescentic, the convexity backwards and outwards; and crosses the bone obliquely, from the posterior border outwards and forwards to the anterior. The distance of the outer end from the external extremity of the bone is sometimes as little as  $\frac{1}{4}$  inch, and this apparently in the most strongly marked bones, but is usually about  $\frac{1}{3}$  inch. Considering the vertical obliquity of the acromial facet, there is fully half an inch of the upper surface external to opposite the mark and the ligament.

The rest of the under surface of the outer third of the clavicle presents two more or less unoccupied spaces, separated by the ligamentous impression; one external and behind, the other in front and internal. The former (*posterior unoccupied space*) is external to the conoid tubercle and behind the trapezoid mark; and has its narrow end posteriorly and internally. It is concave, smooth,

pierced near the outer end by vascular foramina, and unoccupied. The whole of this space is not greater than that occupied by the conoid and trapezoid impressions, which may be said to occupy more than a third of the space presented by the under surface of the outer third of the clavicle. The other part is in front of the conoid and internal to the trapezoid mark, between them and the anterior border, and has its narrow end externally and in front. In front of the conoid tubercle it is usually smooth and concave and longitudinally grooved, being the outer part of the subclavian groove, and receives the insertion of the outer end of the subclavius muscle. The part next the anterior border is less smooth, and flat and irregular. It is a narrow unoccupied space (*anterior unoccupied space*) from  $\frac{1}{4}$  to  $\frac{1}{6}$  inch in breadth, between the attachment of the subclavius muscle and outer part of the trapezoid ligament behind, and the anterior border in front.

*Internal or Cylindrical Portion.*

This, as already defined, embraces the internal two-thirds of the clavicle. It is curved in the opposite direction to the outer third, the convexity forwards; and is thick or at least not flattened, and somewhat irregular looking. The true form of this portion is not at first very apparent. How many surfaces and borders has it, and what is their position and direction? These questions may be easily answered as regards any one specimen, especially if it be a muscular one, but the description will not apply to all; some appear to have four distinct surfaces and borders, some three, and some only two. Still, the examination of a series of specimens, and of the muscular relations, will show that there is a primary or typical form, and the varieties then become easily understood. The arrangement is this—a well marked specimen is quadrangular, or square shaped; what are borders in the outer third have now become broadened or flattened into surfaces; each border, anterior and posterior, apparently dividing into two, an upper and lower division, so as to include an anterior and posterior surface; whilst the two surfaces of the tabular portion, are continued along, still as superior and inferior surfaces, but diminished in breadth. The flattening of

the anterior border into a surface, is to provide for the origin of the pectoralis major muscle, exists only in the internal half of the bone, and is at the expense chiefly of the superior surface. Posteriorly, again, there is a very distinct surface looking to the neck, separated from the true inferior or subclavian surface, by a prominent sharp and smooth line, which runs inwards from the conoid tubercle to the rhomboid impression near the inner end of the bone. This line or border is a continuation of the lower division of the posterior border of the tabular portion. Thus, the posterior border of the outer end sends a line or division downwards and inwards across the prolongation of the deep surface; which in the inner two-thirds is thus divided into a posterior or cervical, and an inferior or subclavian surface, the latter, though the narrower, being the proper continuation of the broad inferior surface of the tabular portion.

We might thus describe four surfaces to the internal portion two—anterior or pectoral, and superior or subcutaneous—corresponding to the superior surface of the tabular portion; and the other two—posterior or cervical, and inferior or subclavian—corresponding to the under surface of the tabular portion. There would thus be four borders also, two anterior, lower or deep and upper or superficial, and two posterior, lower or deep and upper or superficial. But a more simple view than this may be taken of the internal portion. One of the divisions of each border is its true continuation, or border proper, constant in position and character, the other is in each case a special line varying in different specimens. There are thus two primary surfaces corresponding to the two surfaces of the tabular portion, and each is subdivided by a line into two parts. The two primary borders are anterior and posterior, the two primary surfaces superficial and deep. The superficial surface faces upwards and forwards, and is usually divided more or less distinctly into an anterior or pectoral part, for the pectoralis major, and an upper or more properly superficial part. The deep surface faces backwards and downwards, and is divided by a line or border into a posterior or cervical, and inferior or subclavian part. But these two parts of the deep surface must be considered as separate surfaces.

The line or border which separates them, though in some specimens smooth and little prominent in its inner half, is still usually or normally so very distinct as often to appear the most distinct border or edge this part of the clavicle has, forming a rectangular edge between the posterior and inferior parts of the deep surface, which are then more distinctly separated from each other than they are from the superficial surface; and these two surfaces, or two parts of the deep surface, have entirely different relations to the soft parts. We may distinguish this dividing line as the subclavian line or border. Beginning at the conoid tubercle, it passes obliquely forwards across the inferior surface and runs into the rhomboid impression, which exists as a broad rough ridge or impression on the most internal part of the inferior surface of the bone. This subclavian line or border, in dividing the deep surface into two, has an oblique course inwards and forwards, from which it results that, as they pass inwards, the posterior or cervical surface increases whilst the inferior or subclavian surface diminishes in breadth, being, in fact, in its internal inch or more, represented only by the rough rhomboid impression.

*Borders and surfaces to be described.*—With these general considerations we are now in a position to describe the anatomy of the internal portion of the clavicle. Its primary *borders* are two in number, the continuations of the borders of the outer third, one *posterior* or *superior*, the other *anterior*; and to these must be added the *third* or *subclavian* or deep border. The *surfaces* are, two primary, deep and superficial, but the deep one divided into two by the subclavian border. They are, first, the *superficial*, or *anterior superior*, continuous with the superior surface of the tabular portion. In the inner half, the pectoral line crosses it and often divides it into two distinct parts, lower or pectoral, and upper or superficial proper. Second, *posterior* or *cervical*, in a well-marked bone the most distinct surface the clavicle has; concave smooth and unoccupied. And, third, *inferior* or *subclavian*, occupied by the subclavius muscle and rhomboid ligament. Close to and at the internal extremity the shaft of the clavicle becomes much enlarged, and these three borders run in to the three angles of the extremity; the upper

border into the upper angle, the anterior border into the anterior or lower angle, and the subclavian border into the posterior or most prolonged of the three angles; and the three sides of the extremity, between the angles, correspond to the three surfaces, being posterior, anterior, and inferior.

It may be observed here, that in tracing inwards the borders and surfaces from the outer third, they somewhat change their position and direction, giving a partially twisted appearance to the clavicle. The posterior border of the outer third, or tabular portion, becomes more superior than posterior in the inner half; the anterior border in like manner becomes inferior as well as anterior; and the surface which in the tabular portion looks nearly directly upwards, in the inner half looks more forwards than upwards. This gives the twisted appearance to the clavicle, as if the upper part of the inner end had been twisted forwards. We therefore speak of the sterno-mastoid muscle as attached to the upper rather than to the posterior border, and of the pectoralis major muscle as attached to the anterior rather than to the upper surface.

**ANTERIOR BORDER.**—The anterior border is continued directly from the anterior border of the tabular portion, where we found it to be rough and sharp, forming the lower limit of the deltoid impression. Occasionally, however, the inner end of the deltoid impression reaches up, as a sharp angle, a little way upon the surface above the exact border. Tracing it inwards from the outer third, the anterior border is distinct but smooth, for a distance of half an inch to an inch, this being the unoccupied space between the deltoid and pectoral muscles. Having now arrived at the middle of the clavicle, or a little internal to the middle, the border, in a well-marked bone, appears to divide. The upper division passes upwards and inwards across the anterior surface and is the pectoral line, limiting superiorly the impression for the pectoralis major muscle. The lower division is the true continuation of the border, in some bones the upper being wanting altogether as a distinct line. The lower division or true border, is now directed downwards and inwards, usually forming the

lower boundary of the pectoral impression. It is at first distinct and rough, but usually becomes less defined about an inch from the inner end of the bone, traceable, however, more or less distinctly into the inferior angle of the extremity, passing in front of the costal facet, while the rhomboid impression reaches the extremity behind the facet, an unoccupied space being left between.

This border is properly anterior in the outer half of the clavicle, but along the inner half, it is inferior as well as anterior, the change taking place where the pectoralis major begins to be attached, the flattening for this muscle throwing the border obliquely downwards. In the tabular portion it gives attachment, as already described, to the deepest fibres of the deltoid; in nearly the internal half to the deepest fibres of the pectoralis major and the thin fascia behind the muscle; and to the smooth inch or half inch between the deltoid and pectoral impressions is attached only a thin fascia.

**SUPERIOR BORDER.**—The superior border is the continuation inwards of the true or exact posterior border of the tabular portion. There it is strictly posterior, but now it is more properly superior. This, however, is more a relative than an actual change of direction or position. It is still the most posterior part, until at least it arrives at the inner third or fourth, where the bone below it may project farther backwards. The change from posterior to superior is due to the flattening of the bone in the opposite direction to that of the tabular portion, and to the change of direction of the superficial surface, which now slopes forwards, instead of being horizontal as it is in the tabular portion.

Along the tabular portion, this border has been already described as rough, for the attachment of the trapezius muscle. It now becomes smooth and rounded, but is still a distinct border. This smoothness continues until we arrive at the inner third or fourth, where it again becomes rough for the attachment of the sterno-mastoid muscle. It then rises up and runs into the upper angle of the internal extremity of the bone. The attachment of

the sterno-mastoid muscle is not so strong to the border proper as upon the surface in front of the border, whilst part of it is also attached down on the posterior surface behind the border; and the principal roughness on the macerated bone is usually a little in front of the exact border. Sometimes, however, the principal sterno-mastoid roughness is exactly on the border, which is then broader and irregularly raised, and there is sometimes, though not usually, a raised ridge or ridge-like tubercle developed here, an inch or three-fourths of an inch from the inner end of the bone.

The entire length of the attachment of the sterno-mastoid to the clavicle is on an average  $1\frac{1}{2}$  to  $1\frac{3}{4}$  inch, but it begins at a distance of  $1\frac{3}{4}$  to 2 inches from the inner end, as the muscle is not attached to the most internal  $\frac{1}{4}$  or  $\frac{1}{2}$  inch of the bone. The unoccupied space of this border, between the nearest points of attachment of the trapezius and sterno-mastoid, is from  $1\frac{1}{2}$  to  $1\frac{3}{4}$  inch in length. The extent of this, however, it is well known is liable to great variety. It may be increased by especially the sterno-mastoid having a less than usual breadth of origin, or diminished by one or both muscles being broader than usual. I have seen these muscles so broad as altogether to meet each other about the middle of the clavicle. We may, however, conclude correctly enough in general terms, that the upper or posterior border is divided into three nearly equal parts; the external third, on the tabular portion, is rough for part of the trapezius muscle; the middle third, is smooth and unoccupied; and the internal third, is again rough for the sterno-mastoid muscle; but the part for the trapezius is rather more than a third, whilst the middle unoccupied, and the internal or sterno-mastoid parts, are each rather less than a third of the whole border. The sterno-mastoid roughness, on the macerated bone, is seldom apparent above  $1\frac{1}{2}$  inch from the extreme inner end; the most external part of the muscle not being so strong as to roughen the bone.

**THIRD OR SUBCLAVIAN BORDER.**—This line or border has been already defined—as dividing the deep surface of the clavicle

into two parts which form distinct surfaces; one posterior or cervical, the other inferior or subclavian. It extends from the conoid tubercle externally to the rhomboid impression internally. It may be traced even farther outwards than the conoid tubercle, to the prominent posterior angle, where, about an inch from the acromial facet, it joins the true posterior border. Between it and the true posterior border, is included a narrow space, already referred to as properly part of the deep surface of the clavicle, and is now seen to be the narrow outer end of the posterior division of the deep surface, reaching out upon the tabular portion. As a prominent line or border, however, it begins at the inner end of the conoid tubercle or impression. Here it is placed at the back part of the inferior surface. It now extends obliquely inwards and forwards, and runs into the rhomboid impression at about an inch and a half from the internal extremity of the bone. When the rhomboid impression is broad, this line runs into its back part still forming the true boundary of the deep or cervical surface. This subclavian line or border is most prominent in its outer half, corresponding to the middle third of the bone. Internally it is less prominent, for about an inch next the rhomboid impression, and here varies a good deal in different bones as to prominence and sharpness. In slender specimens it forms only a smooth and obtuse angle of separation between the subclavian and posterior surfaces, but in well marked specimens it forms a rectangular separation, the cervical surface looking directly backwards, the subclavian surface directly downwards. It is right, however, to remark that I have several muscular specimens, otherwise well marked, and also several very slender specimens, in which the separation between the posterior and inferior surfaces is much rounded off in the inner half or third of the bone. These, however, are the exceptions; the separation is normally an evident one on the macerated bones, and corresponds to the different relation of the two surfaces to the soft parts.

This line or border forms the exact posterior limit of the insertion of the subclavius muscle, and gives attachment to the back of the sheath or fascia which encloses that muscle.

Whether sharp or rounded, the line is generally a smooth one throughout, at least on its posterior aspect.

**SUPERFICIAL SURFACE.**—This surface is included between the superior and anterior borders, faces forwards and upwards, and is continuous with the upper surface of the tabular portion. Beginning here, this surface is, for about an inch, smooth and convex in its whole breadth. Internal to this, along the inner half of the bone, it presents a division into two parts, an inferior or anterior, rough or more or less flattened, for the pectoral muscle; and an upper, which is in part subcutaneous and in part occupied by the sterno-mastoid muscle. The distinctness of the separation between these two parts varies much in different specimens. It is generally less marked in slender bones, but usually even in them very distinct. Again there are some muscular specimens in which the line of separation is at least not very sharp or angular, the pectoral surface being then distinguished by roughness or irregularity, along with moderate flattening; but usually the dividing line is so prominent that the two parts resemble separate surfaces, and give a quadrangular figure to the inner third of the bone. The lower division, being entirely occupied by the clavicular portion of the pectoralis major muscle, may be called the pectoral impression, and the dividing line, which forms its upper limit, the pectoral line.

*Pectoral impression.*—This impression should be first studied on specimens where it is well marked. It is elliptical in form. Externally, it begins by a pointed apex usually about an inch, but sometimes only half an inch, from the inner end of the deltoid impression. Below, it is bounded by the anterior border of the bone, now thrown somewhat downwards. It appears in some specimens not to reach quite down to the border, the lower pectoral line not being quite identical with the border, but usually it is so, the boundary passing horizontally inwards and then a little upwards to meet the upper boundary, near the inner end of the bone. Superiorly, it is bounded by the *pectoral line*, which, beginning at the outer angle of the ellipse, passes obliquely upwards and inwards, then across, then a little down-

wards and inwards; and then meets or nearly meets the lower boundary at a distance of  $\frac{1}{3}$  to  $\frac{1}{2}$  an inch from the articular margin. The inner angle or end of the impression is sometimes distinctly marked, and I have seen it so  $\frac{1}{4}$  inch from the articular margin; but usually it is not defined as an angle, the impression only narrowing inwardly and then ceasing to be defined at about  $\frac{1}{3}$  inch from the articular margin. The length of the impression is usually  $2\frac{1}{2}$  inches. In short bones it may be only two inches, and in some it is three inches, but in the latter case the length of the unoccupied space between it and the deltoid impression is half an inch instead of an inch. The distance of the outer angle of the impression is usually close upon three inches from the sternal end, and therefore situated almost exactly at the middle of the clavicle. The breadth or depth of the impression is usually about  $\frac{1}{3}$  inch at its broadest part, which is at and internal to its middle. In strong specimens it is 5 lines or even half an inch in breadth, and in slender specimens from  $\frac{1}{3}$  to as little as  $\frac{1}{6}$  inch.

The surface of the impression, from above downwards, is seen in three different conditions, convex, flat, or concave; this depending chiefly on the prominence of the pectoral line, at least the prominence of the line is usually in proportion to the flatness of the impression. In the majority of specimens, it is convex, more or less; in almost all the less marked specimens it is so; and it looks forwards and upwards. In well marked clavicles it is flat or nearly so, and looks either directly forwards—the pectoral line forming a rectangular edge; or downwards and forwards—the pectoral line forming an acute angle, as it occasionally does by projecting so much as to overhang the impression, and make it face obliquely downwards. The concave variety is occasionally seen; it may be slight, but is sometimes well marked. I have before me a pair of clavicles, from a muscular male, but not so large or muscular as several others, and in these two the pectoral impression is an elliptical excavation about two inches in length, nearly half an inch in breadth, and in the middle the hollow is fully  $\frac{1}{8}$  inch deep. Transversely, the pectoral impression is usually convex, following the curve of the

bone at this part ; but when it is flat from above down, the convexity of this curve is considerably diminished ; in the hollow specimens again, it is concave from within outwards also, but the projecting pectoral line overhanging the impression, keeps up the convex outline of this part. Whether the surface be raised or flat or depressed, it is always rough or irregular ; the roughness is perhaps greatest towards the upper part ; and there is sometimes the appearance of a line crossing it transversely, either above or below the middle, which will not be mistaken for one of its boundaries.

The *pectoralis major muscle* arises from the whole of this impression, including its boundary lines, and its extent will be found, on dissection, to correspond to what I have described as the impression on the bone. The attachment is fleshy, from 2 inches to  $2\frac{3}{4}$  in length, and about  $\frac{1}{3}$ , sometimes  $\frac{1}{2}$  inch, in depth. Externally, it narrows both up and down to a point ; internally, it narrows less and chiefly from below, and ceases about  $\frac{1}{4}$  inch from the articular margin, although a few fibres arise internal to this from the anterior ligament of the joint. The narrowing upwards of the inner end of the muscular attachment, leaves an unoccupied space between it and the attachment of the rhomboid ligament.

The *upper division of the superficial surface* is the part between the pectoral line and the inner half of the superior border. Superiorly it gives attachment to the sterno-mastoid muscle, and between this and the pectoral line, it is unoccupied or superficial. The upper of these may be called the sterno-mastoid impression, the lower the median or unoccupied space.

On dissection the following will be found to be the mode of *attachment of the sterno-mastoid muscle to the clavicle*. As already stated, the most internal part is from  $\frac{1}{4}$  to  $\frac{1}{2}$  an inch from the internal extremity, that is, from the articular margin. The total length of the insertion is from  $1\frac{1}{2}$  to  $1\frac{3}{4}$  inch ; so that the outermost part of the attachment is  $1\frac{3}{4}$  to 2 inches from the sternal end of the bone. The attachment is not a broad one, the depth or breadth not exceeding at the broadest part  $\frac{1}{4}$  inch. The outer half inch is very thin. The internal part, for about

an inch, presents a transverse division into two parts or ranges, an anterior and posterior. The posterior range is the thinner, is attached along the border proper, by mixed aponeurotic and fleshy fibres, and also down the posterior or cervical surface by fleshy or also by aponeurotic fibres, usually for about  $\frac{1}{6}$  inch. The anterior range is attached upon the surface, in front of the border, by a series of tendinous slips, and is the strongest part of the insertion. Between the anterior and posterior ranges, there may be a narrow cellular space,  $\frac{1}{8}$  to  $\frac{1}{6}$  inch broad, or it may be occupied by intervening aponeurotic and muscular fibres, but there is, notwithstanding, a marked separation of the insertion into these two ranges. The external half inch appears continuous more with the anterior range, but is on a level between the two. The anterior range approaches more or less to the pectoralis major, leaving a narrow unoccupied or subcutaneous space between.

The breadth of this *subcutaneous space* varies, from  $\frac{1}{6}$  to  $\frac{1}{10}$  inch. In some, however, it may be broader, whilst in others it seems scarcely to exist, the tendinous fibres of the two muscles blending across it. It is broader internally, from the increased breadth of the bone, and from the narrowing downwards and inwards of the pectoral origin. It does not increase externally, as the bone is narrower here, and the pectoral origin has not yet begun to narrow, as it reaches nearly an inch farther out upon the clavicle than the sterno-mastoid. Although the tendinous fibres of the pectoral and sterno-mastoid muscles may blend across this space, they are still fixed down upon it like a periosteum, leaving, therefore, a narrow space, properly speaking subcutaneous. This feels like a broad ridge, bounded above and below by a line where the pectoral and sterno-mastoid muscles properly terminate. This explains the soft feeling which the inner third of the clavicle has anteriorly, although it is convex and prominent, compared to the more directly hard feeling of the part at and for an inch external to the middle, which is uncovered by muscular attachments and subcutaneous in its whole breadth, and may be grasped between the fingers.

On the macerated bone the *sterno-mastoid impression* is not

strongly marked. In well marked bones it is seen as a roughness, or rough elevation, along and in front of the superior border, for its internal  $1\frac{1}{2}$  inch, and sometimes for two inches, but usually the bone is scarcely if at all roughened where the outer half inch of the sterno-mastoid is attached. The principal roughness is in front of the border proper, usually about  $\frac{1}{6}$  inch, but nearer the border internally than externally. This rough elevation might be mistaken for the border, which, however, is seen and felt as a smooth edge, a little behind the outer end of the roughness. In some bones the roughness appears simply on the border, making it rough and broad, and it is in a few only that any roughness is seen down behind the border, where the deepest fibres of the muscle are attached. We may, therefore, define the situation of the sterno-mastoid impression as along the internal third of the upper border, reaching in front of it on the superficial surface for about  $\frac{1}{6}$  inch, where it is roughest, and also a little way down on the cervical surface, behind the border.

In the macerated bones, the breadth of this division of the surface, between the pectoral line and the upper border, varies a good deal according as the pectoral flattening is decided or the pectoral line prominent. It is usually about  $\frac{1}{4}$  inch in breadth, broader internally and narrower externally; but when the pectoral impression is not only flat but cut obliquely so as to face downwards as well as forwards, the pectoral line is then very prominent, and the space between it and the upper border of the bone is broadened in proportion, and may have a breadth of half an inch. In these specimens, the pectoral ridge or line is an acute angle; in the most frequent form of well marked pectoral impression, its surface facing forwards, it is about a right angle; and when the impression faces a little upwards, or is little marked, then the pectoral line is an obtuse or rounded angle. Thus the upper division of the superficial surface is usually narrower, nearly by one half, than the lower or pectoral division, except when the pectoral line forms a prominent acute angle, when it may be as broad as the pectoral division, or even broader.

The *entire subcutaneous part of the clavicle* may be now defined. It is the whole of the superficial surface which is not occupied

and covered by the trapezius and deltoid muscles on the outer third, and the pectoralis major and sterno-mastoid muscles in the inner half. First, there is a part where the whole breadth is subcutaneous, being the space between the nearest attachment of the pectoral and deltoid muscles; the unoccupied or transition space. This space is usually an inch in length, has its inner end exactly at the middle of the bone, and is smooth and convex in both directions. It is the part of the bone which, though not the most prominent, may be most readily felt under the skin, or grasped by the fingers, and in thin persons the middle supra-clavicular nerve or nerves may be felt crossing it, being covered only by a thin superficial fascia and the platysma myoides muscle. Some authors have mentioned the occasional transmission of the middle supra-clavicular nerve through a foramen in the bone, a condition with which I have never met.

The subcutaneous space, from this broad part, narrows inwardly and outwardly, as already described. Outwardly, on the tabular portion it gradually narrows for about  $\frac{3}{4}$  inch, as the trapezius and deltoid gradually approach each other, and then in the external inch, or inch and a half, is only a narrow space between these two muscles. Inwardly, for the first inch opposite the pectoral muscle, it narrows from below as the pectoral muscle gradually encroaches on the surface; and lastly, along the internal third, it is only a narrow space, between the sterno-mastoid and pectoral muscles.

**POSTERIOR OR CERVICAL SURFACE.**—This is the most distinct of the three surfaces of the inner two-thirds of the clavicle. It is bounded, above, by the upper border; below, by the sub-clavian border or line, running between the conoid and rhomboid impressions; internally, by the posterior edge of the internal extremity; and, externally, it runs out as a narrow posterior surface on the tabular portion of the bone, above and external to the conoid tubercle. It is concave from within outwards, forming the back of the great anterior arch of the bone; and either flat or a little convex from above downwards. It is smooth in its whole extent, and unoccupied, covered, of course, by its

periosteum like every part of bone which has no tendon or ligament planted on it. This surface is properly posterior, looking backwards to the root of the neck, and may, therefore, be also called cervical. This aspect of the bone has been described by some as in relation with the great subclavian blood vessels and brachial plexus of nerves. Were it so, these important structures could scarcely escape injury in the common case of fracture of the clavicle, but they have no such relation to it, being separated even from its inferior surface by the subclavius muscle; the artery and vein are much below and on a plane behind; the nerves are much behind and then on a plane below. The only structures in direct relation with this surface, are, at its lower part, the comparatively small transversalis humeri, or supra-scapular, artery and vein.

The *direction* of this surface varies a good deal, being either directly backwards as a vertical wall, or sloping obliquely, so as to face downwards as well as backwards. In examining this, care must be taken to place the clavicle in its natural position, its flat outer end lying with the upper surface sloping only a very little forwards, as the clavicle lying on the table usually turns unnaturally forwards. It is only in a few, and these though strong, not the strongest specimens, that the cervical surface is a flat vertical wall looking directly backwards, meeting the subclavian surface at a right angle. In nearly all well marked specimens, however, the cervical surface approaches to this. It may be a little oblique from greater prominence or roundness near the upper border, and still join the subclavian surface at a right angle. In most of these, however, and in all slender specimens, the subclavian border is more or less an obtuse angle, so that this surface looks more or less obliquely downwards as well as backwards. In some slender specimens, indeed, the separation between the posterior and inferior surfaces is much rounded off, especially to the inside of the middle of the bone, until we arrive at the rhomboid impression, where the separation again becomes angular. The direction of this surface is somewhat different towards the inner end, for about an inch or an inch and a half. Here it looks backwards and a little up-

wards. This is owing to the great prolongation backwards of the posterior angle of the extremity, and also, in cases where it is very strongly marked, to the rhomboid impression pushing backwards the lower part of the cervical surface. When this is strongly marked, it gives a very twisted appearance to the cervical surface; its outer part facing backwards and downwards, or directly backwards, and its inner part, backwards and upwards. In most specimens, however, the upward obliquity of the internal inch of this surface is but moderately marked, and in some, very slightly. This part usually gives origin to the highest fibres of the sterno-hyoid muscle. This attachment is usually close above the inner part of the rhomboid ligament, and therefore from the lower part of the cervical surface; and for a breadth of about half an inch, but the attachment is not sufficiently strong to occasion a roughening or mark on the bone. Sometimes, the highest fibres of origin scarcely reach so far up as this, but come only from the ligaments at the back of the sterno-clavicular articulation, the part to which the middle fibres of the origin are usually attached, the lowest passing upon the sternum, and, it may be, also the first costal cartilage.

The *breadth* of this surface diminishes gradually from within outwards. Close to the sternal extremity it has a depth, or breadth, of  $\frac{3}{4}$  inch to an inch; at the junction of the middle and internal thirds, it is about  $\frac{1}{2}$  inch; at the junction of the middle and external thirds about  $\frac{1}{3}$  inch. It is now *continued upon the tabular portion* as the narrow third surface already alluded to. It usually appears at first to be even broadened here by the projection downwards of the conoid tubercle, but the base of the tubercle is its proper lower boundary. This narrow third surface extends upon only the inner half of the tabular portion, altogether terminating at the prominent angle, about an inch behind the acromial facet. It is bounded above by the true posterior border; below, by the base of the conoid tubercle and the rest of the conoid impression inwards and outwards from the tubercle. It is a little convex in both directions; looks either directly backwards, or downwards and backwards if the conoid tubercle does not project much back; is slightly rough; and is occupied by a few of the fleshy fibres of the trapezius muscle.

Internally, it is about  $\frac{1}{3}$  inch in breadth or depth; externally, it has contracted to  $\frac{1}{4}$  or  $\frac{1}{6}$ ; and, now arrived at the prominent angle, it narrows into a mere border, bounding posteriorly the ligamentous impression. This tapering, or pyramidal figure, of the bone from within outwards, is, especially along the outer third, partly deceptive; the tabular portion being thinner towards the borders than along its middle, as the measurements show.

*Nutritious Foramen.*—The nutritious foramen is usually situated on the posterior surface at or near the middle of the bone, but varieties occur frequently, both as to position and number. It may be placed on the inferior surface, in one out of every four or five cases, if I may judge from thirty specimens now before me; but in most of those in which it is below, there is a second foramen on the posterior surface. As to number, there may be two foramina, and then either both on the posterior surface, or one there and the other on the inferior surface. In either case they are very seldom close to each other, but at a distance, longitudinally, of from half an inch to an inch; and of unequal size. In one specimen there are three on the posterior surface, one a little internal to the middle, the other two an inch external to it and within  $\frac{1}{8}$  inch of each other longitudinally. In another, there are five distinct foramina,—two on the posterior surface, one large and median, the other half an inch external to it,—and three on the inferior surface, one median, and the others an inch on each side of it.

In the common arrangement—one foramen on the posterior surface—it may vary in position both longitudinally and vertically, that is, it may be farther in or out on the bone, or farther up or down on this surface. Longitudinally, it is usually placed near the middle of the bone; occasionally exactly at the middle, or half an inch or a little more to either side—as often to one side as the other; most frequently at some point within these limits. At first it looks as if the foramen were generally external to the middle, but this is owing to the posterior surface not reaching to the acromial end; and a series of measurements will show the position above described to be the usual one. When placed on the subclavian surface, the foramen is seen in one well

marked specimen to lie at the middle, while the second foramen, on the posterior surface, is more than half an inch internal to the middle; in another, the foramen on the posterior surface is median, while the larger one, on the subclavian surface, is more than half an inch external to the middle. Vertically, it is seen to vary so as occasionally to be up near the upper border, more frequently low near the subclavian border, but most frequently about midway between. When placed on the subclavian surface, it is usually far back, close to the subclavian border, but in one specimen it is  $\frac{1}{8}$  inch in front of this, as if it had been covered by the subclavius muscle. The position longitudinally seems often to determine the vertical position, the highest being the most external, and when there are two foramina, the farthest out seems to be usually the highest; but by no means necessarily so, as the opposite is often enough seen. In the two specimens above referred to, in which there is a foramen also on the subclavian surface, the latter is the most external of the two by more than half an inch, and in one of these, farther, the subclavian foramen is nearly as far out as the junction of the middle and outer thirds of the bone; whilst, were it a general rule that the foramen was higher the farther out, those on the subclavian surface would occur towards the inner end, and those towards the outer end would be found up near the superior border. The foramen it may be observed, is not symmetrical on the two sides, in any respect. Thus, of three pairs of clavicles before me, in one pair, the foramen is an inch farther out on the left side; in another, they correspond longitudinally, but one is on the posterior, the other on the inferior surface; and in a third, it is single and median in one, while on the other bone there are two, one behind and farther out, and the other on the subclavian surface. I have not seen the arrangement symmetrical in any one instance.

The foramen is invariably directed very obliquely outwards, and is usually of considerable size, larger proportionally in young bones. It commonly begins as a groove, which deepens outwards for  $\frac{1}{8}$  or  $\frac{1}{6}$  or even sometimes  $\frac{1}{4}$  inch, until it dips into the foramen proper. This is then at first often a short

vestibule from which two foramina or canals open, the external passing more obliquely outwards, the internal sinking more directly into the bone. This, however, is not always visible from the outside even when the foramen is large. The early bifurcation of the canal might be thought of in connexion with the not unfrequent occurrence of two separate foramina, were it not that these, as already described, are seldom close together, have both the same oblique direction outwards, and, in two of my specimens with two separate foramina, one of each shows the same arrangement of a vestibule and two openings therefrom.

**INFERIOR OR SUBCLAVIAN SURFACE.**—This surface may be very appropriately called subclavian, as it is truly the inferior, or below the clavicle, and as is in relation with the subclavius muscle. It is the direct continuation inwards of the under surface of the tabular outer third of the bone; becomes gradually narrower as it passes inwards; is bounded, in front, by the anterior border, and, behind, by the subclavian border which separates it more or less abruptly from the posterior or cervical surface. It may be divided from within outwards into two parts, the first or internal, rough and prominent, for the attachment of the rhomboid ligament, about  $1\frac{1}{4}$  inch in length; and the second or external, two to three inches in length, usually slightly grooved, for the attachment of the subclavius muscle. The former may be named the rhomboid impression, the latter the subclavian impression and groove.

*Rhomboid impression.*—The attachment of the rhomboid or costo-clavicular ligament is from an inch to  $1\frac{1}{4}$  in length, beginning very close to the articular margin. The internal part of the ligament is thick, the external third or half being about half the thickness of the rest. The attachment to the bone is broader than the thickness of the ligament would lead us to suppose although it is a very strong ligament, as it passes obliquely upwards and backwards and thus runs obliquely upon the bone; resembling in this respect the trapezoid ligament, the impression for which we have seen is much broader than the thickness of the ligament. The rhomboid impression corre-

sponds to this attachment. It appears to occupy the entire breadth of the internal part of the subclavian surface for an inch to  $1\frac{1}{4}$  in length, but its inner half is separated from the lower pectoral line, or anterior border, by a smooth unoccupied space, broadening inwards, opposite which the costal facet is situated.

The rhomboid impression presents different appearances; usually it is a broad rough mark; sometimes it is a broad prominent and rough ridge or process, projecting downwards and backwards; and occasionally, it presents a rough excavation. In the great majority of specimens it is a broad rough mark, only slightly prominent. It begins externally, from 1 to  $1\frac{1}{2}$  inch from the edge of the sternal extremity, but this depends somewhat on the part of the extremity to which we measure, as the posterior angle is much prolonged. Measuring to this part, it may be  $1\frac{1}{2}$  inch, but measuring straight in to in front of the posterior angle,  $1\frac{1}{4}$  will be found to be the usual distance. Here, at the outer end, the impression is pointed and less marked; it now increases in breadth as it passes inwards, and terminates very near the articular margin, a little in front of the prolonged posterior angle of the extremity. The impression is less marked at its inner end, and may present no defined termination, losing itself near the articular margin; but the attachment of the ligament comes very close to the articular margin. The length of the impression is therefore usually  $1\frac{1}{4}$  inch; the breadth is usually greatest about the middle, and is  $\frac{1}{4}$  inch, or even  $\frac{1}{3}$  inch when strongly marked, but less in slender specimens; and from this, it contracts outwardly to a point, but less inwardly. In some specimens, however, the broadest part is internally, giving the entire impression a triangular figure; and there are two of my specimens in which the broadest part is externally. The latter occurs in the specimens in which the impression is elevated into a broad ridge or process. In one dissection, the thickness or breadth of the attachment of the ligament on both sides was  $\frac{1}{3}$  inch externally, and  $\frac{1}{4}$  inch internally, and the prepared bones now show a corresponding form of impression. In this form, the impression or process presents a sharp or prominent ledge projecting backwards, throwing the inferior or subclavian border backwards, or

even projecting backwards behind the level of the posterior surface. Again, the impression may present a decided excavation, in some running longitudinally in the centre of the impression, or in others the whole impression is as if a piece of the bone had been scooped out, leaving a broad rough excavation encroaching a little upon the posterior surface. I have seen the outer part of the rhomboid impression raised as a flat process, covered with cartilage and synovial membrane, and forming a joint with a similar projection from the cartilage of the first rib. The rhomboid ligament was divided, or hollow, so as to enclose this joint. Not unfrequently the clavicle and costal cartilage are nearer each other than usual, and the rhomboid ligament is short and very thick and spongy looking almost like spongy fibro-cartilage.

In the common form of rhomboid impression, it is bounded posteriorly exactly by the subclavian border, the impression and attachment of the ligament thus reaching quite back to the lower boundary of the posterior or cervical surface of the bone. Anteriorly, it is bounded at its outer part by the anterior border, which here also forms the lower boundary of the pectoral impression, so that at its outer part the rhomboid ligament comes, at least usually, close to the pectoral muscle; but, internally they separate, the pectoral impression narrowing upwards towards the anterior angle, while the rhomboid impression narrows backwards and runs obliquely towards the posterior angle of the extremity. There is thus left a triangular *unoccupied space* between the inner part of the great pectoral muscle, in front; the inner half of the rhomboid ligament, behind; and the articular margin internally. Here the bone is usually smooth, convex from before backwards and concave from within outwards. The length of the triangular space is from  $\frac{1}{2}$  to  $\frac{3}{4}$  inch or even an inch; and is more or less encroached on according to the extent to which the articular surface turns round the edge to form a costal facet, but along with a well-formed costal facet it may still be  $\frac{3}{4}$  inch in length. Towards the base, which is internal, the breadth of this space is  $\frac{1}{2}$  to  $\frac{3}{4}$  inch, being nearly the whole space between the anterior and posterior angles. The space results from the enlargement of the bone towards the

extremity, and also, at the same time, from the narrowing and divergence of the pectoral and rhomboid attachments as they approach the extremity. This space might be reckoned a part of the subclavian surface, as the lower pectoral line is the continuation of the anterior border; in which case the rhomboid impression would occupy only the narrow back part of the surface in the internal  $\frac{3}{4}$  inch, instead of representing the whole surface. In the natural state this unoccupied space is filled by a loose cellular or also fatty tissue, and here the joint is very easily opened.

The remaining part of the inferior surface is entirely occupied by the attachment of the subclavius muscle, and may be termed the *subclavian impression*. Internally, where it meets the rhomboid impression, it is narrow and somewhat irregular, as it proceeds outwards it becomes gradually broader, and also more or less grooved and smooth; and this smooth and grooved part extends about half an inch outwards on the tabular part of the bone, in front of the conoid impression. Instead of being grooved, this surface may be nearly flat, and divided longitudinally by a faint ridge, but to understand this part it is necessary first to examine the muscle.

The *attachment of the subclavius muscle* begins, usually immediately external to that of the rhomboid ligament, occasionally even a little in front of the outer end of the ligament; and therefore about  $1\frac{1}{4}$  inch from the sternal extremity. It extends outwards as far as to in front of the middle of the conoid impression, more or less occupying the angular space between the conoid and trapezoid ligaments, and therefore within  $1\frac{1}{4}$  to  $1\frac{1}{2}$  inch of the extreme part of the acromial extremity. The total length of the insertion is usually about three inches. Examined from before backwards, it is seen to occupy the whole or nearly the whole breadth of the surface, and, like it, to increase in breadth outwards. Posteriorly, it comes quite to the inferior or subclavian border, which gives attachment to the most posterior fibres of the muscle, but more especially to the back part of the aponeurotic sheath of the muscle in the whole length between the rhomboid ligament internally and the conoid ligament exter-

nally. Anteriorly, it approaches the anterior border, but does not come quite close to the deepest fibres of the deltoid and pectoralis major, as there is a narrow, but variable, space between. They are also separated by the attachment of a very strong aponeurosis, or ligament—the coraco-clavicular membrane or fascia—which at its attachment along the anterior border of the clavicle forms the front of the sheath of the subclavius. This membrane indeed, may be said to split below the subclavius, passing both before and behind it to be attached to the clavicle, and form a case or sheath for the muscle, reaching from the rhomboid ligament internally, to the internal edge of the conoid and anterior edge of the trapezoid ligament externally. It is also continued downwards, diminishing in strength, to the edge of the pectoralis minor, in front of the axillary vessels and nerves. It is an error to regard the sheath of the subclavius as continued down from the fascia of the neck; its posterior part begins, or terminates, exactly at the subclavian border, immediately behind the subclavius muscle. There seems to be some variety in the precise relation of the muscles, and this separating fascia, to the anterior border, along the inner three-fourths of the bone. Sometimes the fascia is attached to the exact border, and there is a narrow unoccupied space between it and the deepest part of the pectoralis major, and sometimes the pectoralis comes down to the exact border, whilst the fascia is attached a little behind it, especially as it passes outwards. The border is, however, often obscurely marked in its inner half, being thick and rounded, we may correctly enough regard it, on its deeper aspect, as the anterior limit of the subclavius, and the line of attachment of the front of the sheath or coraco-clavicular membrane. The total breadth of the insertion of the subclavius is, at its inner third,  $\frac{1}{8}$  to  $\frac{1}{6}$  inch, and having gradually increased outwards, at its outer third,  $\frac{1}{3}$  inch. The mode of insertion deserves notice. Posteriorly it is fixed to the subclavian border by a thin layer of aponeurotic and also fleshy fibres; anteriorly it is fleshy, and to the smooth grooved surface also fleshy; but concealed in the interior of the muscle there is a tendinous or aponeurotic septum receiving the fleshy fibres, running longitudinally

and fixed to a perceptible line. This aponeurotic septum begins very near the inner part of the attachment, and, concealed in the muscle, runs outwards and obliquely forwards, and shows itself as a tendon at the fore part of the outer end of the muscle, while the back part of the outer end is fleshy and close in front of the conoid ligament. This intra-muscular septum varies in strength, it may be a strong continuous sheet of tendon, or only a longitudinal series of aponeurotic bands. This explains what had previously puzzled me to understand—the not unfrequent existence of a line running longitudinally upon the subclavian surface of the bone, dividing the groove into two parts.

The *subclavian impression*, as seen on the prepared bones, begins at the outer end of the rhomboid impression; is bounded, behind, by the subclavian border, in front, by the anterior border, and externally, terminates on the tabular part of the bone in front of the conoid tubercle. It is about three inches in length, occupying, therefore, rather more than the middle half of the clavicle, as there is a fourth of the bone external to it, and less than a fourth internal to it occupied by the rhomboid impression. It is at first very narrow, increasing in breadth outwards, but no part of this surface is broad, until we get upon the tabular part of the bone, upon which the subclavian impression runs for half an inch. At its inner third, the breadth is  $\frac{1}{8}$  to  $\frac{1}{6}$  inch, more like a broad border than a surface, and in some specimens it is even narrower; at its middle, which is also at the middle of the bone, it is  $\frac{1}{6}$  to  $\frac{1}{4}$  inch, and at its outer third usually  $\frac{1}{3}$  inch. The surface of this space is at first flat and irregular for about the first inch, at any rate there is no groove, but a more or less rough or even raised surface. In its outer two-thirds, the space is more or less grooved, forming the *subclavian groove*. This groove seldom becomes distinct internal to the middle of the bone, but when well marked it begins very narrow at the junction of the internal and middle thirds. The groove is usually about 2 to  $2\frac{1}{2}$  inches in length, and occupies the whole breadth of the subclavian surface. What is here called the groove is identical with the outer two-thirds of what is above described as the subclavian impression, being the grooved condition of the latter. But this groove or

grooved condition varies much in different specimens. It may be a simple broad and well marked groove, or it may be more or less filled up, and divided by a longitudinal line as if into two parts, but the posterior of these is the true groove. The line is sometimes seen distinctly behind the anterior border, as a faint line or longitudinal roughness, and corresponds to the attachment of the concealed aponeurosis of insertion of the subclavius. The majority of specimens do not show this line distinctly, and when the groove is simple and broad there is no appearance of it; the concealed aponeurosis of the muscle seems to vary in strength, and may be attached along the front or some part of the groove.

Although the floor or surface of the groove appears pretty smooth, yet when closely examined it is seen to be streaked longitudinally, and this faint roughness may be developed into the faint longitudinal line already described; at the inner part, again, near the rhomboid impression, this surface is usually more decidedly rough, sometimes even elevated instead of grooved. The perfect smoothness and polish of the posterior surface, which is unoccupied, contrasts with the faintly roughened aspect of the subclavian surface; and the longitudinal direction of the streakings corresponds to the direction of the fleshy or aponeurotic fibres of the subclavius muscle which are implanted upon it.

The subclavius muscle does not occupy the whole breadth where it extends on the tabular part of the bone. As already described, the conoid impression and ligament occupy about the posterior third; then come the outer end of the subclavian groove and muscle, about  $\frac{1}{3}$  inch in breadth; and in front of this, between the subclavius behind and the attachment of the deltoid muscle to the anterior border in front, there is a narrow space already referred to as the anterior unoccupied space, —reaching outwards to where the trapezoid ligament meets the anterior border, and inwards as far as the deltoid goes, where it becomes very narrow. This space may be  $\frac{1}{6}$  to  $\frac{1}{4}$  inch in breadth, is somewhat irregular or rough, and across it is attached the coraco-clavicular membrane, which runs close in front of the subclavius muscle, all the way from the outer end of

the trapezoid ligament externally, to the outer end of the rhomboid ligament internally.

It may be well here to correct the natural inference from some descriptions, that the subclavian groove is deep and large enough to contain or lodge the subclavius muscle. In specimens where it is best marked, its greatest depth is less than  $\frac{1}{8}$  inch, whilst usually it is much less. Only a small part of the subclavius muscle, therefore, can be lodged in it, as the muscle is about as large as the clavicle itself at the middle. It was emphatically described by the early anatomists as "*musculus qui sub clavicula occultatur*"; but its concealment is due simply to its lying below the clavicle, and to its being bound firmly in there by its strong aponeurotic sheath.

Viewing the inferior surface of the clavicle in its whole length, it thus presents three distinct relations to the soft parts; the internal  $1\frac{1}{4}$  inch, rather less than a fourth of the entire bone, belongs to the rhomboid ligament; next comes the subclavian impression, about three inches in length, grooved in its outer two-thirds, receiving the subclavius muscle; lastly there is the outer third, two inches in length, on the tabular portion, attaching the conoid and trapezoid ligaments, the subclavius muscle, however, also placed upon its first half inch.

#### INTERNAL OR STERNAL EXTREMITY OR HEAD.

The sternal extremity, for the sake of brevity, may be called the head. It presents the articular surface, or face, looking towards the sternum; and, surrounding this, a rough margin, or non-articular part, for ligamentous attachment, which includes about  $\frac{1}{3}$  or  $\frac{1}{4}$  inch of bone outwards from the exact articular margin. The head is much the largest part of the bone,—twice as large as the middle of the shaft. The enlargement is gradual, and in most strong specimens continues so up to the articular margin, which is only a very little elevated and rough; but in many specimens, including nearly all the slender ones, there is a more abrupt enlargement of the last half inch. The enlargement in all, is greater at the lower and back part, the head being

always considerably prolonged in this direction so as to form a prominent and rounded posterior angle.

In form, the head is either triangular or oval, but the triangular is the fully developed and typical form. In studying the position of these angles, we must be sure that the bone is in its natural direction, and this is easily ascertained by seeing that the flat outer end is so placed that its upper surface is nearly level, sloping only a very little forwards. The head being triangular, presents *three angles* or corners, and between these *three borders*, edges, or sides. The angles are, one superior, and two inferior, one of these being anterior, the other posterior; the latter is the most prominent or prolonged angle. The edges or borders are, one anterior, looking forwards and upwards; one posterior, looking backwards and upwards; and one inferior, looking towards the sternum or costal cartilage, and often crossed by a prolongation of the articular facet. In the great majority the head has these three distinct angles, especially in muscular specimens, but also in the majority of slender ones; in many, however, especially in the slender specimens, the form is elongated or oval. This form results from the absence or greater or less rounding off or non-development of the anterior angle, or to the upper and anterior angles being less developed and united by a convex anterior border. If a series of heads be compared, after this explanation, the apparently great diversity of form will be readily understood. The perfect form is the triangle, the occasional oval resulting from the non-development of the anterior angle, or its fusion with the superior, whilst the posterior or prolonged angle remains unchanged in position and as the most prominent, although it may vary in the degree of prolongation.

The nature and meaning of the head cannot be understood without a previous understanding of the nature of the sternoclavicular articulation. What was wanted was great strength with limited motion, and diminution of shock. The strength is secured by strong ligamentous connexion, binding a prominence down upon a shallow socket, instead of by a cavity deeply receiving a prominence; the ligaments allow of all the motion required, which may be a little in any direction, but is chiefly that

resulting from elevation and depression of the shoulder; and the shock, from forces transmitted inwards from the shoulder, is obviated at this joint, first, by the connexion being ligamentous more than by osseous reception, and also by the interposition of the soft and elastic disc of fibro-cartilage, which is at the same time employed as a strong ligament. Hence the great size and roughness of the head, and the comparatively small and shallow socket into which it is bound down. The shallow socket is formed by the semilunar notch of the sternum, and, in one sense, also partly by the cartilage of the first rib, which joins the sternum exactly at the lower and outer end of the notch. The end of the clavicle is larger than this socket, in all directions, and it is only the lower part of the end which is shaped so as to fit the socket; but at no part does it touch the sternal socket, as the disc lies between, with an independent synovial cavity on each side.

*Angles and borders of the head.*—These include the non-articular part of the sternal end, that is, the edge or boundary of the sternal surface, and about  $\frac{1}{4}$  or  $\frac{1}{3}$  inch outwards from the edge, where the bone is rough for ligamentous attachment. The well formed head presents for description three angles—superior, posterior and anterior; and three intervening borders—anterior, posterior, and inferior or costal.

*Posterior or prolonged angle.*—This angle is much more prolonged or prominent than the others, and always projects considerably towards the neck, behind the level of the sternum. As seen from either side it is a much rounded angle: but seen on edge it appears sharp, as the sternal surface forms an acute angle with the back of the shaft, the angle being prolonged so as to form a projecting ledge of bone. The subclavian border of the shaft, here represented by the posterior edge of the rhomboid impression, is traced towards this angle, but rather before it, as the rhomboid impression runs in rather between the angle and the costal facet. This angle gives attachment to two strong ligamentous bands; one from the lower part of the posterior edge of the sternal notch, which passes upwards and outwards; the other from the costal cartilage, passing upwards and inwards, appearing as if the inner end of the rhomboid ligament,

but it is properly a more posterior and internal band. These two strong ligaments each about  $\frac{1}{3}$  inch broad, meet by their neighbouring edges, and embrace the posterior angle, running on the bone for  $\frac{1}{4}$  or  $\frac{1}{3}$  inch.

*Superior Angle.*—The superior angle, though not so prolonged as the posterior, is usually in the well marked bone, more angular looking, as seen from the sternal surface, but seen on edge it is blunt and tubercular looking. The superior border of the shaft is continued into it, and meets it about  $\frac{1}{3}$  inch from the articular margin. Looking on it from above, it is seen to have the form of a triangular elevation, bounded in front and behind by rough lines, as if the bifurcations of the superior border of the shaft, and internally, by the articular margin. The outer part is more or less rough, but the inner part is bevelled towards the articular edge and smoother, sometimes, indeed, quite smooth, as if articular. To this angle is attached the interclavicular ligament, a thick strong band, which, as it approaches the angle, spreads out to be inserted upon it, and runs on the bone for about  $\frac{1}{3}$  inch, being attached to the whole of what is just described as the three sided space. The strongest part of the ligament is attached to the inner bevelled part, and the absence of a defined separation between the sternal surface and this angle, is explained by the direct continuity of the interclavicular ligament with the upper attachment of the interarticular fibro-cartilage or disc.

*Anterior Angle.*—This angle is inferior as well as anterior. The anterior border of the shaft runs towards it, but subsides before it actually reaches it. It is best distinguished as the anterior boundary of the costal facet, and when this is small or narrow, the angle is less distinct. In a well formed bone, it is nearly a right angle as seen from the sternal face, and seen on edge, a somewhat sharp one, turned outwards by the anterior end of the costal facet. It exists more to give space below for a broad costal facet than for ligamentous attachment; but it may give attachment, by its anterior edge, to a ligamentous band proceeding from the costal cartilage.

The *anterior edge*, or border, faces forwards and a little up-

wards. It is a sharp edge, a little convex inwards, and nearly straight or a little convex forwards. It gives attachment to the strong and broad ligamentous band, called the anterior sterno-clavicular ligament. The stronger part of this ligament may be attached to the higher part of this border, near the interclavicular ligament, with the deeper fibres of which—those that pass from the top of the sternum to the superior angle of the clavicle—it is altogether continuous. The attachment of the anterior ligament is also for about  $\frac{1}{4}$  inch beyond the exact edge, and there is a corresponding roughness on the bone.

The *posterior edge* faces obliquely backwards and upwards. It is either convex backwards, or nearly straight. Seen on edge, it is sinuous—inwards, a little concave above, and convex below, the latter owing to the inward and backward prominence of the posterior angle. It is thin or sharp, as it is prolonged so that the sternal surface meets the back of the shaft at an acute angle. External to it the bone is rough for  $\frac{1}{4}$  sometimes even for  $\frac{1}{2}$  an inch upon the back of the shaft, which is continued up to the edge without any abrupt rising. The attachment of the ligament is continued for about  $\frac{1}{4}$  inch beyond the edge, and external to this the periosteum is very thick, apparently from the more superficial ligamentous fibres running into it, and this may explain why, in very strong specimens, there is a marked roughness for fully  $\frac{1}{2}$  an inch outwards from the posterior edge. It gives attachment by its lower part to the so-called posterior sterno-clavicular ligament, which is chiefly, as already mentioned, attached to the posterior angle; by its upper part, it gives attachment to the ligamentous band which connects the latter with the deep aspect of the interclavicular ligament, completing the capsule posteriorly. The fact is, there is truly, as some describe, a capsular ligament at this joint, wanting, however, below at the costal facet; the more anterior portion is what is called the anterior ligament, and the lower and posterior part what is called the posterior ligament, but the upper margins of these are joined by fibres from front to back, across the top, where they are connected with the deeper fibres of the interclavicular ligament, and give it a hold upon the sternum.

The *inferior or costal edge* is more or less pushed outwards, by the prolongation of the articular surface to form a horizontal portion or costal facet, with which it will be described. It forms the outer edge of this variable facet, is more or less convex outwards, and is usually a sharp edge. The apparent lower boundary of the triangular face, is formed by the articular edge by which the sternal and costal facets are continuous.

The occasional *oval form* of the head, as already pointed out, is chiefly due to the absence of the anterior angle, or to the anterior and superior angles being closer together, and joined by a more or less convex and short anterior edge. In this form, there are properly only two angles and two borders. The angles are, the posterior, the most prolonged, and placed as in the triangular form; and the anterior, pointing forwards and upwards, usually but not always the broader of the two. The latter appears variously, as a rounded angle, or short anterior edge more or less convex between the superior and anterior angles, which are thus near to each other and but moderately developed; or one of these angles, especially the superior, may be more prominent than the other, thus making the anterior end of the oval point either more upwards or more forwards. The edges of the oval are, one superior and posterior, the other inferior and anterior. The former may be the straighter of the two, if the anterior end projects much more upwards than forwards; but usually the lower or costal is the straighter, and the upper and posterior convex, and sometimes semicircular. The flattening of the lower is in connection with the position of the narrow costal facet. The long axis, or direction, of the oval, might be supposed to be horizontal from the way the bone lies on the table, but if placed naturally, so that the outer end has only a slight inclination forwards, it will be seen that the true direction of the oval is neither horizontal nor vertical, but obliquely between the two. The fore part of the lower edge thus appears to be raised up from contact with the costal cartilage, and accordingly there is no broad costal facet with the oval form of sternal end, although we find on dissection that there is the same costal pouch of synovial membrane, prolonged below the articular edge at this

part. In the oval form, I have found the interclavicular ligament to be attached considerably behind the anterior end, to what is then the posterior and upper border; whilst the anterior end of the oval gave attachment to the anterior ligament of the joint.

It is not easy to say what determines the oval form. If the form is more generally somewhat oval in the young bones, this must be attributed merely to their not being fully grown; the same may be said of the slender adult specimens, in which a greater muscular activity would have more brought out the typical form; and, as it is, the majority even of very slender specimens present the distinctly triangular form, though the angles and edges are less sharply defined. Moreover, my best marked specimens of the oval have very strongly marked muscular impressions; especially the pectoral impression is very flat or even concave, and looks downwards and forwards, making the pectoral line above it very angular—that is—the inner part of the shaft is flattened in the direction of the long axis of the oval head. This corresponding shape of head and neighbouring half or third of shaft, seem to stand in relation to each other, but neither as seemingly the cause of the other, for the downward and forward direction of the pectoral impression is due to the great prominence of its upper boundary more than to a falling off at its lower, such as the absence of an anterior angle to the sternal end might occasion. Also, it may be asked, is the anterior angle wanting because a costal facet for some other reason is not needed, or is the facet wanting because the form is oval, so that it does not approach the costal cartilage?—more probably the latter.

STERNAL SURFACE.—This is the end proper or face of the sternal extremity. We have to consider its shape, size, direction, and surface. The *form* has been already defined, being the same as that of the non-articular parts which bound it. The triangle is not equilateral; the longest edge is the posterior, the next the inferior, as the posterior angle is the most prolonged, and the superior more so than the anterior. All the edges are

usually convex, but occasionally straight, according as the angles are less or more developed; the inferior, however, formed by the costal surface, may be concave. The *size* varies much in different specimens, usually in proportion to the muscularity of the bone, except when it has the oval form, when the actual size is much diminished although the specimen is a muscular one. The antero-posterior diameter (from posterior angle to middle of anterior edge) is from  $\frac{3}{4}$  inch to an inch, and the vertical diameter (from upper angle to middle of inferior edge) is about the same, but it may be nearly  $\frac{1}{4}$  inch more when the upper angle is well developed. In the majority of specimens, however, the antero-posterior measurement exceeds the vertical, on account of the prolongation of the posterior angle, and always does so if we take the vertical measurement from a little behind the superior angle, intersecting the antero-posterior at right angles. In the oval form, the long diameter is nearly an inch, the short  $\frac{1}{2}$  to  $\frac{3}{4}$  inch, thus making the total surface considerably less than in the ordinary triangular form.

*Direction.*—What is here meant is the direction with reference to the rest of the bone, not the direction given to it by the oblique position of the bone in the neck. Is this surface cut at right angles, or obliquely, to the shaft? The prolongation at and near the posterior angle renders this part and the posterior border an acute angle, but the general sternal surface may not the less be at right angles to the shaft on this account, as we must not be misled in this respect by mere sharpness from prolongation, or obtuseness from rounding off. Antero-posteriorly, the end may be cut somewhat obliquely from behind forwards and outwards, the posterior part projecting a little, so that the face looks a little forwards as well as inwards; but this obliquity is not great, the natural forward obliquity of the surface being due to the oblique position of the bone. From above downwards, the end may be cut either at right angles, or obliquely downwards and outwards. These two conditions are or may be irrespective of the inequalities of the surface, but will be found to explain the varieties presented by at least the lower part of the articular surface, and also those of the socket. In the one

form, the sternal surface stands vertically or nearly so; the lower part is then built out into a rounded articular surface, which therefore exists also below the bone, forming what is called the costal facet. In the other form, the end is cut obliquely, so that the upper edge is overhanging, and the lower part is wanting or cut off, so that there is no rounded articular prominence below. The sternal surface, therefore, may have an obliquity in both directions,—antero-posteriorly, so as to look a little forwards as well as inwards,—and secondly, from above downwards, so as to look down as well as in. In the latter direction the obliquity may be great, or may not exist at all; so that two forms must be distinguished, which may be spoken of as the vertical and the oblique or overhanging, when we come to consider their influences on the form of the articular surface.

The *surface* when viewed in a series of specimens, seems to vary so much both as regards smoothness or roughness, and convexity or concavity, that it appears difficult to give a definition or description which shall apply to all, or to understand the true principles of its construction; but this will be cleared up by a careful examination of the recent joint and of a series of sterna and clavicles.

We must first distinguish a part, above, which is not articular, but is occupied by the *attachment of the inter-articular fibro-cartilage or disc*. This attachment begins at the upper angle, and reaches down upon the sternal face from  $\frac{1}{6}$  to  $\frac{1}{4}$  or even  $\frac{1}{3}$  inch, and forwards and backwards, below the anterior and posterior edges, on an average for  $\frac{3}{4}$  inch—that is—from before backwards the attachment is  $\frac{3}{4}$  inch, and the depth at the middle, where it is deepest, about  $\frac{1}{4}$  inch. It reaches usually as much in front of the upper angle as behind it, but sometimes considerably more behind than before, and may then appear to be attached as far back as near the posterior angle. Care must be taken in estimating the exact attachment of the disc to the clavicle, as at its circumference it adheres to the deeper fibres of the anterior and posterior ligaments, the attachments of which might be mistaken for attachments of the disc. But where it is truly attached, as above described, it is also truly blended with

the deeper fibres of these ligaments, especially with the interclavicular, and this renders it difficult to estimate the precise depth of the attachment. In a section, the two form one continuous attachment  $\frac{1}{3}$  or  $\frac{1}{2}$  inch in depth, part of this, however, being upon the bevelled part of the upper angle; but, excluding what of this properly belongs to the ligament, the disc is fixed to the bone usually for about  $\frac{1}{4}$  inch, and therefore for about a fourth part of the entire depth of the sternal face. Also we are apt to suppose that the disc is attached farther back than it really is, as the articular cartilage towards the posterior angle is usually in a very spongy condition, like fibrocartilage, and is continuous with the neighbouring part of the posterior ligament and of the disc. On the macerated bones, this attachment of the disc is not usually very distinctly indicated, but it may be discerned as a flat or slightly prominent rough space, of a somewhat crescentic form, very convex or angular above and somewhat concave below, like a broad margin descending from the upper angle and from the edges in front and behind, and limited below by the excavation which indicates the commencement of the articular surface. This part, which may be called the *ligamentous crescent*, occupies about the upper fourth of the surface; the remainder is the articular surface proper.

*Articular Surface.*—The articular surface, when fully formed, presents two parts, one on the face or end of the bone, the other continued from it underneath the extremity; these are continuous with each other round the lower edge of the extremity, and may be distinguished as the vertical and horizontal portions, or as the *sternal and costal* facets, although the latter is more sternal than costal.

*Sternal Facet or vertical portion.*—This presents two parts from above downwards—one occupying the middle region of the entire sternal face, concave, the other inferior and convex. The *concave* part is irregular, both in the extent and degree of its concavity; it may be only an irregular excavation running from before backwards, or a general concavity occupy-

ing a large part of the entire end. The concavity is in both directions, and is usually more marked from before backwards than vertically. The *lower or convex part* owes its vertical convexity chiefly to its being continued underneath as a costal facet. From before backwards, it may also be convex or nearly flat, but just as often it is, like the part above it, concave in this direction, and therefore saddle-shaped, the convexity vertical, the concavity antero-posterior. It now runs underneath as the costal facet, which usually has the same form, convex from within outwards, in continuation of the vertical direction, and concave antero-posteriorly, although just as often the costal facets are convex in the latter direction also. It amounts to this, therefore, that the entire sternal facet is, from above downwards, first concave and then convex, and from before backwards, concave above, and below either concave or convex. The essential character of the articular surface seems to be, a double concavity or hollow above, and a convexity below in at least the vertical direction.

*Costal Facet or horizontal portion.*—The costal facet is said to be occasionally or not unfrequently present, but it would be more correct to say that it is occasionally absent. It is in no case a separate facet, but only a prolongation of the sternal facet outwards below the end. When fully formed, the costal facet has usually the shape of the end of a blunt or obovate leaf rolled in below the end of the bone; when narrow it is more of a crescentic form. The base is where it joins the sternal facet, by a rounded connecting edge, which is usually an obtuse angle, sometimes very obtuse, but in large and well formed specimens it is often nearly a right angle, at the same time smooth and rounded off. The relative direction of the two surfaces depends on the slope of the sternal aspect, more than on any change in the direction of the costal facet.

Here, at its base, the costal facet occupies the greater part of the distance between the anterior and posterior angles; is usually quite close to the anterior angle, being indeed the cause of its prominence; but usually does not extend so far back as to the

posterior angle, occupying commonly the anterior two-thirds of this edge, but it may be only a half, or on the other hand three-fourths. The oval or crescentic figure is seldom symmetrical but has a broad and a narrow or tapering side; the broader side is almost always the anterior, and the most extreme or bulging part, or end of the oval, is usually directed forwards and outwards. It is bounded by a distinct margin, which in strong specimens projects as a sharp everted ledge, sometimes as much as  $\frac{1}{8}$  inch. It projects less at the most extreme part of the facet, as this is rolled up, as it were, closer to the bone, in order to carry out the required convexity of the facet from within outwards; and this part of the edge is consequently concave downwards as well as convex outwards. This edge or border of the costal facet, may be looked on as the true inferior or costal border of the sternal extremity, pushed outwards by the costal facet, although, in looking at the sternal surface, the lower edge of the triangle is represented by the rounded articular edge which connects the sternal and costal facets.

In size, the costal facet varies most from within outwards; antero-posteriorly, at its base, along the connecting edge, it is usually  $\frac{1}{2}$  an inch in length, seldom if ever less, and in large bones it may be almost an inch. From within outwards, it presents all degrees of breadth, from a mere narrow articular edge to  $\frac{1}{3}$  or even  $\frac{1}{2}$  an inch; but the ordinary well marked costal facet is usually  $\frac{1}{4}$  to  $\frac{1}{3}$  inch at its broadest part. It is not uncommon to find it only  $\frac{1}{6}$  or  $\frac{1}{8}$  inch, and in the specimens in which it appears at first to be wanting, it is usually present simply as a mere cartilaginous edge visible below. These, as already remarked, are the cases in which the sternal end has the oval form; the anterior and inferior part of the extremity is then wanting, thus rendering a costal facet unnecessary, as the clavicle then does not come so close as usual to the costal cartilage, although I have seen a costal facet of some breadth on an oval extremity. A synovial pouch will, however, always be found prolonged here whether there is a well formed costal facet or not, the synovial membrane lying smooth on thin and spongy cartilage, or on a cellular bed only, without any defined platform of bone and articular cartilage to support it, and there-

fore leaving little or no trace on the macerated bone. Usually, however, this facet, whether a broad oval or a narrow crescent, has a defined edge, and the synovial pouch goes out beyond it, this laxity being necessary to allow of the outward and inward motion of the costal facet, or lower edge of the extremity according as the shoulder is raised or depressed.

The surface of the costal facet is always convex from within outwards, forming a continuous convex surface with the vertical convexity of the lower part of the sternal facet. From before backwards, it may be either concave or convex; apparently just as often the one as the other. In some of my largest specimens, with large facet, it is convex, in others concave; and the same may be said of slender specimens. When the antero-posterior concavity of the sternal facet is strongly marked, it is more likely to extend down and give the costal facet the same form, but not necessarily so; and again, when it is only a narrow crescent it is more likely to be concave in this direction.

Viewing, then, the entire articular surface of the inner end of the clavicle, including both sternal, and costal facets,—we now see, that, from before backwards, it is concave above, and below either convex or concave; and that, from above downwards, there is first a concavity, and then a convexity, the latter including the lower part of the sternal and the entire costal facet. Considered with reference to the shallow socket which receives it, the articular surface of the clavicle, may be divided into two parts, an upper, concave in both directions, fitting upon the upper half of the semilunar facet on the sternum, which presents a double convexity; and a lower, including the costal facet, convex vertically, which corresponds to the angle or middle and to the lower part of the semilunar notch, and also in part to the costal cartilage.

#### SOCKET FOR THE CLAVICLE.

The surfaces of the sternum and costal cartilage form what may be called the socket, although it is very shallow and in

part convex. The articular part of the socket is formed entirely by the semilunar notch of the sternum. The cartilage of the first rib joins the sternum exactly at the lower end of the semilunar notch, and its upper border becomes flattened and broad as it approaches the union, so as to form an apparent continuation outwards of the semilunar cavity, but it does not present a smooth or polished articular surface. It supports a bed of fibrous and cellular tissue, on or over which the costal facet of the clavicle plays; and in this sense only does the costal cartilage form part of the socket; a very important part, however, as resisting the passage of the end of the clavicle downwards. Although the clavicle at no part actually touches the sternum, on account of the interposed disc, they are, notwithstanding, moulded to fit each other and allow of the motions of the clavicle. The *lower attachment of the disc* begins, behind, at the lower part of the posterior edge of the semilunar notch, and from this, reaches obliquely outwards and forwards, at first still on the sternum, and then, at its most external and anterior part, on the costal cartilage. It is thus nearly across the line of junction of the sternum and costal cartilage, which is somewhat oblique in this direction, but the attachment of the disc has a still greater obliquity. This obliquity has reference to the direction of the clavicle, which, being forwards and inwards, requires the disc to face backwards and outwards. The lower attachment of the disc thus divides the general costo-sternal socket into two parts—one the sternal or articular part proper, the other external, costal, or non-articular part.

The *Costal Part* is a triangular space; the base internally ( $\frac{1}{3}$  to  $\frac{1}{2}$  inch) formed by the fore part of the lower attachment of the disc; the apex externally ( $\frac{1}{3}$  to  $\frac{1}{2}$  inch outwards from the base) where the border of the rib begins to broaden; bounded behind by the inner part of the rhomboid ligament; and in front it would be open but for the synovial membrane. This triangular space or surface is slightly concave in both directions. It is covered by the external of the two synovial membranes of the joint, but, instead of a polished articular sur-

face, presents a soft fibrous and cellular bed, on which the synovial membrane is laid. This bed is formed by fibrous bands which connect the costal cartilage to the first rib, and by a prolongation outwards of fibres from the attachment of the disc. The disc cannot be lifted off it, as there is no prolongation of the other synovial membrane in between the disc and the costal cartilage, but part of its fibres are here prolonged horizontally outwards to assist in forming the soft bed which floors the costal part of the socket, and on this is laid, loose and soft, the prolongation of the external synovial membrane, as it passes horizontally outwards between the costal cartilage and the lower aspect of the inner end of the clavicle. This little triangular space corresponds, above, partly to the costal facet of the clavicle when it is large, and to the little triangular unoccupied space already described on the clavicle, as situated between the costal facet internally, the rhomboid ligament behind, and the inner part of the pectoralis major in front.

The *Sternal Part* of the socket is formed by the semilunar notch, and is a smooth and polished cartilaginous surface. The form is not semilunar but oval, both edges being convex, the anterior the most so. The long axis is from above downwards and outwards, and is usually  $\frac{3}{4}$  inch in length; the breadth, or from before backwards, is usually  $\frac{1}{2}$  an inch; or both about  $\frac{1}{12}$  inch more. The length may be only  $\frac{1}{2}$ , or as much as a whole inch, but in the latter case we are apt to have included a portion of the adherent and ossified costal cartilage. It is bent in the direction of its length, but the bend is more particularly at one part, thus dividing it into an upper, sloping, or ascending, and a lower, outer, or horizontal portion. This is the true view to take of this surface—the ascending part is that against which the face of the clavicle pushes, the horizontal part is that upon which the costal facet rests, and the rounded angle between receives the part of the clavicle which connects the sternal and costal facets.

The upper or *ascending portion* is not vertical, but slopes downwards and outwards, and is convex in both directions.

The antero-posterior convexity especially is marked, and most so in front; the vertical convexity is principally above, and ceases at or near the bend. This double convexity renders the ascending portion not properly, at least of itself, a socket, but a prominence, sometimes, indeed, so great as to feel like a smooth and rounded tubercle or button, and it is usually or often more distinct or prominent on the right side than on the left. The lower or *horizontal portion* may also face somewhat obliquely outwards, but is usually nearly horizontal. It is concave from within outwards; antero-posteriorly, like the costal facet of the clavicle which rests on it, it may be either nearly flat or concave or convex, perhaps more frequently the latter. The division or angle between these two parts is not direct, but oblique from behind forwards and outwards, which corresponds to the oblique direction in which the clavicle is set upon it; for the same reason that farther out, the lower attachment of the disc has a similar oblique direction.

*Variations of the Sterno-Clavicular surfaces.*—The relative size of these two portions of the sternal notch, and the abruptness of the angle between them, varies a good deal, but the variations seem to be explained by referring to those of the clavicle. Usually, the ascending or sloping portion is much the largest, and the bend between it and the horizontal portion is a rounded off obtuse angle. To fit this, the end of the clavicle has a well built out and rounded lower edge, fitting into the bend; a consequently less sloping end, fitting by its shallow excavation upon the prominence of the upper part of the ascending portion of the semilunar notch; and a more or less broad "costal" facet, resting on the horizontal portion of the semilunar notch, and reaching out upon or over the costal cartilage when the head of the clavicle moves down, as it does when the shoulder is raised. Of course the disc is interposed, its upper part lying obliquely and its lower part horizontally, between the opposing surfaces. But sometimes the sternal notch is very shallow, and as if all formed by the ascending portion, now more sloping than usual; the clavicle is then not built out at its articular edge, but is overhanging or cut obliquely downwards and outwards, with little

or no angle or prominence between its sternal and costal facets, or is cut so obliquely that there is no costal facet at all, but only a narrow articular edge. The sternal notch and the clavicular surfaces are then usually, in their whole extent, concave in the antero-posterior direction. Again, in the oval form of the head of the clavicle, the costal facet or horizontal part of the articular surface is, as already described, usually represented only by a narrow articular edge; if in such a case the sternal notch has a horizontal part, this narrow margin seems naturally to rest in the bend or angle, the clavicle external to it not touching the sternum, unless when the narrow articular edge plays out upon it when the shoulder is raised.

*Mechanism of Sterno-Clavicular Joint.*—These forms of surface allow of the required motions at this joint. The clavicle may glide a little forwards and backwards; this it does by a concave surface shifting forwards and backwards upon a fixed convex surface. At the horizontal part of the joint, the convexity and concavity may be the reverse, but this is not incompatible with antero-posterior gliding, even if this part really has such a motion, as the head of the clavicle may rest on this part, tied down by the rhomboid ligament, while, by a kind of rotatory motion, it glides a little forwards and backwards on the ascending part of the notch. But the head of the clavicle moves chiefly up and down, according as the shoulder is depressed or raised. Here the vertical convexity at and near the lower edge, moves in or out upon the vertical concavity, at and near the angle or bend between the horizontal and ascending parts of the sternal notch. The costal facet naturally lies on the horizontal part of the sternal notch, and it is only when the shoulder is much raised that it glides outwards, if not upon, at least above, the costal cartilage. To allow of this, the pouch-like prolongation of the external synovial cavity is required, although cartilaginous surfaces are not. Had the clavicular attachment of the disc been below, it would have been carried outwards and would have checked this motion; but, by being fixed to the clavicle above, it is made to serve also the purpose of a ligament, in preventing the head of the clavicle from rising too far out of the socket, as in

the constant tendency to depression of the shoulder. Hence a reason for the great upward projection of the head of the clavicle, giving room for the attachment of the disc, as also for the strong ligaments attached to this and other parts of the head. The greater size of the head compared with the socket which in part receives it, is also partly on the same principle as that on which the head of the humerus is larger than the glenoid cavity.

The above description of the surfaces at this joint, may not apply to all cases; occasionally the sternal surface of the clavicle is very irregular, and, indeed, rough besides; and the sternal notch may be different, for instance, it may be a pretty deep cavity, concave in both directions, and is sometimes rough; but these are exceptions, and no doubt the opposite surface was, in each of these cases, such as to fit. The parts I have described as articular surfaces, are, in the macerated bones, represented by the smooth and polished articular lamina on which the cartilage is laid. Some bones want this lamina, the articular surface being then in whole or in part porous or rough, though not so frequently so as the articular facet at the acromial end of the bone. This is apparently explained by the occasional very spongy and irregular condition of the cartilage; it is sometimes quite broken up into tufts over the whole articular surface, and not unfrequently presents a velvety surface, which appears to be an earlier stage of this condition. Although there may be no irregularity of its surface, the cartilage is often spongy or compressible, and is, indeed, generally so towards the back part, at and near the posterior angle. Immediately below the upper attachment of the disc, the cartilage is often wanting, just at the upper part of the double concavity described, the bone appearing as if covered by periosteum merely, but this is for a narrow space only. The cartilage on the sternal side of the joint seems to be much less liable to assume this spongy or irregular condition.

*Length—Direction—Form—Mechanism—Structure—and  
Varieties of the Clavicle.*

LENGTH.—The length of the adult clavicle varies from  $5\frac{1}{2}$  to  $6\frac{1}{2}$  inches. This is the straight measurement from the extreme

part of the head to the extreme point of the acromial extremity, at the posterior end of the acromial facet. The measurement following the curves would be a little longer, but the straight measurement of course gives the actual length. It is usually longer in the male than in the female. The longest male clavicle I have seen is  $6\frac{7}{12}$ , the shortest  $5\frac{8}{12}$ , the majority being 6 inches; the shortest in the female  $5\frac{3}{8}$ , the longest  $5\frac{7}{8}$ , the majority being  $5\frac{1}{2}$  inches. The clavicle in the male is therefore, on an average, half an inch longer than in the female.

**DIRECTION.**—As the clavicle passes outwards it is always directed more or less backwards, which may be termed the backward or forward obliquity. It may be also directed a little upwards or downwards, which may be called the *upward or downward obliquity*. The latter obliquity is not great. Judging by the articulated skeletons, it apparently slopes upwards and outwards, so as to be about half an inch higher towards the outer than at the inner end. This is more apparent on looking along the lower aspect, as if the bone was thinned outwards at the expense of the lower part. The upward or downward obliquity in the skeletons may, it must be remembered, be artificial, according to the fancy of the articulator. In the dead and living subject, when the shoulders are raised or depressed, the clavicle has a corresponding slope upwards or downwards, but in the natural or easy position, the clavicles do appear to rise little as they pass outwards.

The *backward obliquity* is constant, and necessary to the formation of the arch of the shoulder; the clavicle slopes backwards, the scapula forwards, and the arm is suspended below the angle of the V shaped arch thus formed. The amount of this obliquity may be estimated in three ways; by laying on a straight line across the front of the sternal ends, and then noting how far it passes in front of the outer end; again, by laying the line across between the bones at their most posterior part, which is at the prominent angle about an inch from the acromial end, and noting how far it crosses behind the sternum or sternal end; or, more exactly, by laying a straight line across the thorax on the middle

of both sternal ends, and another from the middle of the sternal end to the middle of the acromial end, and noting how far the outer end of the latter is behind the former. The second method will give the obliquity a little greater than the first, on account of the greater breadth of the acromial end. The obliquity varies in different skeletons, even after making due allowance for the errors of the articulator, and must evidently do so in different persons according as the shoulders are held back, or lie forwards as in those who stoop. The obliquity varies under these different circumstances from  $1\frac{1}{2}$  to 3 inches. I have never seen it more than three inches, unless in an evidently incorrectly articulated skeleton, and never less than an inch. It is usually from two to three inches; and it appears from my table of measurements, that most of the instances of the greatest obliquity are in females.

A line drawn across between the most posterior part, near the acromial end, will be found to intersect the spine, on a level with the first dorsal vertebra or the seventh cervical, or between the two; and to run through usually the back part of the spinal canal; when the obliquity is great, it may intersect the spinous process, or when it is least, the line may pass even a little in front of the bodies of the vertebrae. The varying depth of the aperture of the thorax should be looked to in connection with this. From the upper edge of the sternum to the spine is usually 2 to  $2\frac{1}{2}$  inches in the male and  $1\frac{1}{2}$  to 2 inches in the female. This is a reason why the clavicle should appear to be less oblique in the male, having farther to pass back till it can get to the level of the spine; but independent of this, as already stated, the obliquity seems to be actually less in the male than in the female.

As a result of this obliquity, the distance between the outer ends of the two clavicles is usually only a little greater than the united length of the two bones, although the space between the two sternal ends, varying from  $1\frac{1}{4}$  to 2 inches, is usually  $1\frac{1}{2}$  inch. Thus, the clavicles being each 6 inches, and the inter-clavicular space  $1\frac{1}{2}$ , the entire space is not  $13\frac{1}{2}$  but  $12\frac{1}{2}$ . This is easily illustrated; lay two narrow slips of paper, each six inches long, horizontally on the table,  $1\frac{1}{2}$  inch apart; then push the outer ends two inches backward, having marked their former position;

each will now be found to have lost half an inch, and their outer ends formerly  $13\frac{1}{2}$  are now  $12\frac{1}{2}$  inches apart. The clavicles by their obliquity thus together lose fully an inch, which is rather more than made up by the distance between their sternal ends. The measurement from acromial end to acromial end varies from 11 to  $12\frac{1}{2}$  inches, occasionally  $\frac{1}{2}$  an inch more or less; this, however, does not give the extreme breadth of the shoulders, as the outer edge of the acromion is  $\frac{3}{4}$  inch to an inch farther out than the middle of the acromio-clavicular joint. This, accordingly, varies from 12 to 15 inches. In the adult female it is 12 to 13, but was in one 14; in the adult male it is usually  $14\frac{1}{2}$ , the lowest  $13\frac{3}{4}$ , the highest 15. Of course, it is not doubted that instances may occur of greater or less breadth of shoulders in male or female; and part of the breadth of the male shoulder depends on his usually larger head of humerus and thicker deltoid muscle. The breadth of the sternum, or distance between the sternal notches, or inner ends of clavicles, does not seem to be greater in the male than in the female.

In accordance with this oblique direction of the clavicle forwards and inwards, the sternal notch has a backward direction. This is so marked that the notch is not visible in a front view of the sternum. The axis of the joint seems to be nearly at right angles to the axis of the sternal half of the bone, and the clavicle thus pushes against a directly resisting surface, instead of tending to slip forwards off the sternum, as it would if the notch had not faced sufficiently backwards. The same principle we have seen to be carried out at the acromio-clavicular joint, the axis of which is nearly at right angles to the axis of the outer third of the clavicle.

The position of the clavicle as regards the direction of its surfaces has been already fully explained. The surfaces and borders are at once placed in their natural position by so holding it that the upper surface of the outer third faces upwards and also a very little forwards.

FORM.—The clavicle is always more or less bent antero-posteriorly—is it also curved upwards or downwards? This is best

seen by holding the bone up and looking along its front or back, or again by laying it on the table, but the sternal end must then be allowed to project over the edge, as its prominence in all directions might make the shaft appear concave both above and below. Care must also be taken to survey the upper and under surfaces and not the borders, otherwise the antero-posterior curvatures may be mistaken for curvatures upwards or downwards. It is now seen that the bone appears to taper gradually from within outwards; and that there is really very little upward or downward bend, along the lower aspect particularly. There is generally, however, a slight bending of the upper surface; the inner two-thirds being convex, and the outer third or fourth concave. The latter appears to result from the elevation of the ligamentous impression at the outer end, giving the surface a scooped out appearance internal to it; and also from a slight rising of the bone at the inner part of the attachment of the trapezius. This part sometimes rises so much as to give the appearance of a decided upward convexity, just above the conoid tubercle and internal to this, and especially in those bones where the antero-posterior curvature of the outer third is very marked. Generally, it appears that the upper aspect is a little convex in its inner  $\frac{2}{3}$ , and a little concave in its outer  $\frac{1}{3}$  or  $\frac{1}{4}$ , but it may be quite straight, and that in some of the strongest specimens. Even in these, if we include the sternal end, there is, of course, a concavity near it both above and below, which is either more abrupt or more gradual according as the head rises more or less abruptly. The inferior aspect may appear concave along the inner  $\frac{2}{3}$  when seen from behind, but this is due to the downward projection of the conoid tubercle; and for the same reason, the outer fourth may appear concave below, when seen from behind; but again, the whole of the inferior aspect may be straight, as it usually is when seen from the front. In some skeletons, as we see in some persons, the anterior curve of the inner  $\frac{2}{3}$  is directed somewhat upwards, giving the bone greater prominence than usual, but this is not to be mistaken for an upward convexity of the upper surface.

The *antero-posterior curvatures* are two in number, the internal,

convex forwards, occupying the inner  $\frac{2}{3}$  or cylindrical portion of the shaft; and the external, concave forwards, and occupying the outer  $\frac{1}{3}$  or tabular portion. The whole bone is thus sigmoid or bent like an elongated *J*. The *internal or greater curve*, presents its concavity on the superior and subclavian borders and the included cervical surface; its convexity on the anterior border and anterior part of the superior surface. This convexity is modified by the condition of the pectoral impression. When this is flat, the greatest convexity is then usually represented by a prominent pectoral ridge, but sometimes this ridge is not very projecting, and then the convexity of the curve is considerably flattened. Internally, the convexity runs towards but not quite to the sternal end, as there is always more or less of a concavity close to it, from the prominence of its anterior angle and edge; externally, it terminates at the commencement of the deltoid impression. The concavity begins at the superior angle and posterior edge of the sternal end, and reaches to the conoid tubercle or near it, but when the external curve is strongly marked, the concavity does not extend farther than to the beginning of the outer third. The concavity and convexity of this curve are parallel to each other, or nearly so; and the curve is uniform, the greatest projection being at its middle, or a little external to this, but still internal to the middle of the bone. The variation as to flattening of the pectoral impression may destroy the exact parallelism of the two sides of the curve; and as they approach the sternal end they necessarily cease to be parallel, owing to the enlargement.

The *external or lesser curve* presents its concavity along the anterior border and deltoid impression, and reaches quite to the anterior angle of the acromial extremity. It may either form a uniform sweep, or be more bent near the centre; and is liable to interruption by the occasional projection of the deltoid tubercle near its inner part. The convexity of the lesser curve extends along the outer third of the posterior border and the narrow surface below it; and is neither uniform nor parallel to the concavity. It sometimes forms a uniform bend, but usually projects considerably at one of two parts,—either opposite the conoid

tubercle, or more usually farther out, at the prominent angle about an inch from the acromial facet, which is at all times the most posterior part of the bone whether it is the most prominent or not, on account of the outward obliquity of the clavicle. The form of the outer third or fourth of the clavicle is indeed most various. It always increases more or less in breadth outwards till at about an inch from the end, and now it usually diminishes, in some very little, in others very much and at the expense of the back part; and, besides this, the bend forwards of the last inch is much more abrupt in some than in others. Those specimens which may have a very broad outer end generally present a large and long acromial facet, but not always.

Another method of viewing the bent form of the clavicle, is to regard it as forming *arches*, and these may be estimated by laying a straight line or rod along its anterior or posterior borders, so that it touches the two most prominent parts; or, more simply, by placing it upon the table, first on one edge and then on the other; the depth and extent of the included hollow or concavity of each arch is then seen. The clavicle is thus seen to form two arches corresponding to the curvatures, but more extensive, each reaching beyond the point where the middle and external thirds meet, until it arrives at the most prominent point of the next curve. The *internal or greater arch* extends from the posterior edge of the sternal end, usually to the prominent angle near the acromial end, occupying, therefore, about the inner  $\frac{3}{4}$  of the bone. The included concavity is from 4 to 5 inches in length, and  $\frac{1}{2}$  to  $\frac{3}{4}$  inch in depth at the deepest part, internal to its middle. The outer side of the arch is more elongated or tapering than the inner, as its outer part is formed by the commencing convexity of the external curve. This arch, having its convexity forwards, forms a protecting bow or arch across the root of the neck, in front of the great blood-vessels and nerves, and must enable the clavicle to sustain direct injury much better than if this part had been straight. The *external arch* rests, externally, on the anterior angle of the acromial end; internally, on the prominence of the internal curvature, a little

internal to the middle of the bone, and is from 3 or  $3\frac{1}{2}$  inches in length. It may be said to occupy the outer half of the bone. Its greatest depth is usually half an inch, opposite the deepest part of the external curve; and the inner side of the arch is long and tapering, as it is formed by the commencing convexity of the internal curve. This arch, unlike the internal, does not seem to serve a direct purpose, as an arch, but to result from the bone, after completing its first and great arch, requiring to turn forwards to meet the acromion process. The meaning of the sigmoid form of the clavicle may perhaps be better comprehended by looking to these two arches than to the convexity and concavity of each curvature; by the latter the bone is divided into outer  $\frac{1}{3}$  and inner  $\frac{2}{3}$ , each as if a separate curve; by the former it is seen to form two arches, a greater or internal, occupying  $\frac{3}{4}$  of the bone, and a lesser or external, occupying its outer  $\frac{1}{2}$ . The arches, besides the concavities of the two curves are thus also formed by part of the neighbouring convexity, just as, although one side of a valley be convex, it does not the less contribute to the formation of the hollow.

A simple method of showing these arches is to take a pair of clavicles, and place them against each other, front to front, and back to back. The included space gives the length of the arch and twice its breadth. Laid back to back, they include an elongated ovoid, reaching  $\frac{3}{4}$  of the length of the bone; the narrower and more elongated end externally. Laid front to front, the included space reaches  $\frac{1}{2}$  the length of the bone, and has its narrow elongated end at the greatest convexity of the internal curve; and, after touching here, the shafts diverge more or less towards the sternal ends.

*Variations of the Curvatures.*—These are numerous, and when we survey many specimens, it appears at first very difficult to generalize regarding them. It is evident, however, that the principal differences depend on the form or at least on the breadth of the external curve or outer fourth of the bone. It has been said that the clavicle is less curved in the female and in the child than in the male; and that in the latter it increases

in curvature in proportion to its size or roughness; *i. e.*, the greater the muscular development, and use of the bone, the more is it curved. In the female, it is generally smoother, like all other bones in non-muscular subjects; and, besides, may be generally less curved, but by no means necessarily so, as, in not a few female specimens, the double curve is much better marked than in some of the most muscular males. Muscular development, indeed, tends rather to fill up than increase the curves; for the strongest male specimens are not by any means the most curved, especially when the outer end is broad. There are two kinds of outer end, irrespective of all other conditions, and whether from male, female, or child—the narrow and the broad. In the narrow kind, the convexity of the curve is more or less parallel to the concavity, the posterior border not running out but turning forwards; and in these the curve is best marked. In the broad kind, the breadth is obtained at the expense of the curve; the concavity is partly encroached on, especially at the deltoid tubercle, and the posterior border, instead of turning round, runs more outwards, and the bone is built out posteriorly into a very broad acromial end, the facet appearing to occupy the anterior half, instead of the whole as in the narrow variety. In most of these broad outer ended bones, the outer curve appears much less, but in some of them the last inch appears more abruptly bent forwards. These broad ended specimens may be made to appear much more curved by concealing the outer and back part with the finger, thus cutting off what they have in addition to those which are more curved. The statement that the clavicle is less curved in the child cannot have been founded on much observation; the fact is exactly the opposite. This bone, the earliest to ossify in the whole skeleton, is well formed in the foetus, and is laid down originally with its curves, which certainly do not fall short of those of the adult; indeed the curvature seems to be greater in the foetus and child than in the adult, as the bone seems to acquire greater proportional thickness with growth and muscular use. These points are well illustrated by progressive series of specimens from the foetus and child at all ages, now before me; from which it is also evident that there

are varieties in the degree of curvature in the foetus as well as in the adult.

Regarding the curves and their varieties we may therefore conclude—(a) that the curves exist at least as much in the foetus and child as in the adult, and are therefore part of the original design, for certain purposes still to be considered. (b.) That in the adult the slender and smooth specimens are generally also the least curved; most of these belonging to female skeletons, but often enough slender and female specimens are highly curved. (c.) The most highly curved specimens are generally from muscular males, in which, at the same time, the outer end has not a great breadth. (d.) The very muscular and therefore strongest specimens are generally not the most curved, as their usual great breadth towards the outer end fills up the curve especially on the convexity. (e.) And, lastly, that exceptions may occur to these general statements, presenting either curvature greater or less, independent of the form of the outer end.

The *actual amount of curvature* may be estimated by laying a straight line along the bone. It may be laid on, 1st, from the posterior edge of the sternal end to the posterior end of the acromial facet; or 2d, from anterior edge of sternal end to anterior end of acromial facet; or 3d, from the upper angle of the sternal end to the middle of the acromial facet. It is only the least bent clavicles along which a straight line can be laid so as to intersect any part of both articular extremities, and not run off the bone at one or both of its concavities; in the cases where it can, it must be laid on from the posterior end of the acromial facet to the anterior part of the sternal. The 1st of the three lines above mentioned, after marking off a posterior concavity, crosses the outer third of the bone in a variable position, scarcely, if ever, behind its middle; usually farther forwards, so as to leave much more of the flat portion behind than before it; and in much curved specimens, it again leaves the bone for a little, marking off an anterior concavity. The 2d of the three lines, marks off the anterior concavity, and runs along the inner half of the bone, leaving a variable part of the anterior convexity in front of it,—very little when the pectoral impression flattens this part much,

but when the internal curve is great, it may lie as far back as the posterior border or concavity of the curve. But the best of these lines is the 3d (from upper angle of sternal end, or middle of sternal facet, to middle of acromial facet) as it may be considered the straight axis of the bone. Care must be taken that this line runs to the middle, not the posterior end, of the acromial facet, as the facet indicates the outer end proper, and is the only part against which the scapula presses. This line (axis of the clavicle) runs off the bone usually at two parts, marking off part of both concavities, and crosses the shaft more or less obliquely, external to the middle,—with less obliquity the greater the curvature. The internal curve is rarely so slight that the axis does not run behind it, but lies along its back part, while at the same time the outer curve may be well marked; on the other hand it is less uncommon to find the outer curve so filled up in front that the axis runs along its fore part without leaving the bone.

The most exact method of estimating the curves, is, in addition to the employment of the straight axis already defined, to compare it with a curved axis, made by drawing a line on the bone along the exact middle of its upper aspect, following the curves; being identical at the ends, with the ends of the straight axis, opposite the middle of the sternal and acromial facets. We now see the exact point of intersection, and the breadth, length, and form of the two spaces included between the sigmoid line and the straight one. It is then seen that the usual point of crossing is internal to the point of junction of the outer and middle thirds, through some part of the unoccupied space between the deltoid and pectoralis major muscles, the internal curve being therefore less than twice the length of the external; that, in well curved specimens, each curve is about half an inch in depth, the external being rather the deeper of the two; and that, in less curved specimens, the diminution may affect either curve or both, but the external generally remains the greatest, even although the outer end be very broad, as, increase of breadth does not necessarily affect the position of the curved axis. The place of crossing of these two axes is evidently that where a

force in the direction of the bone will be most apt to produce fracture.

*Torsion of the Clavicle.*—The clavicle has always a more or less twisted appearance. The anterior border, as it passes inwards below the pectoral impression, becomes partly inferior, and the superior surface becomes anterior as well as superior. Also, the cervical surface near the inner end becomes more directly posterior or even faces a little upwards as well as backwards, and the posterior border becomes superior along the inner half; but these changes are not so much due to the borders passing spirally, as rather to the change of form of the bone, the inner half being almost flattened in the opposite direction to the outer, becoming narrower, and thickened downwards. This affects only or chiefly one surface and one border; the posterior border still keeps nearly if not quite posterior, but is superior upon the bone; the cervical surface continues to be posterior; the subclavian surface to be inferior; but the anterior border is thrown downwards by the superficial surface now also facing forwards as well as upwards. The change of direction of one surface does not necessarily change that of the others, as the anterior border merely runs in upon the subclavian surface, narrowing it but not changing its direction. The torsion of the clavicle is, therefore, not general, but affects only the superficial surface and anterior border, and results from the change of form, principally to accommodate the pectoralis major muscle. In some specimens, however, especially those with an oval shaped sternal end, the inner fourth or third has a decided general twist, the cervical surface facing obliquely upwards as well as backwards.

The clavicle does not usually lie in a natural position on the table, but this is not due to its partial torsion, or to any upward and downward bend of the shaft, but to the varieties of the ends, especially of the sternal. If laid on its upper surface it usually lies very flat, and we see there is very little upward or downward bending, though usually the outer fourth is a little raised off the table. When it lies thus, the parts visible are, behind, the cervical surface; below, the subclavian surface; and

in front, the pectoral impression. Laid on its under aspect, it usually rests on the extremities only, or falls forwards and leans also on the anterior convexity, and the superior surface of the tabular part then faces very much forwards. This depends on whether the sternal end is triangular; if it is decidedly so, the bone will lie nearly naturally, or incline only a little more forwards than natural; if the anterior angle of the head is but moderately developed, the bone may also lie thus, but easily falls forwards; and if the head is oval, the bone at once falls forwards and rests on the anterior convexity of the shaft, as well as on the head and on the anterior angle of the acromial end.

*Change of form at different parts.*—The outer third, or tabular portion, is evidently much flattened from above downwards; the inner half, on the contrary, appears rather to be somewhat flattened in the opposite direction; and between these there is a transition part, the unoccupied space between the pectoral and deltoid impressions, possessing an intermediate or transition form. The changes of form may be ascertained by measurements of the antero-posterior and vertical diameters at these three parts,—the 1st, or internal measurement, at the middle of the pectoral impression, about  $1\frac{1}{2}$  inch from the sternal end; the 2d, midway between the pectoral and deltoid impressions; and the 3d, through the broadest part of the outer third, usually less than an inch from the acromial extremity. Each of these is towards the outer part of the corresponding third of the shaft. The antero-posterior measurement is the breadth, the vertical diameter is the depth or thickness. The following conclusions are drawn from a table of these measurements in twenty specimens, including all forms. The figures are lines— $\frac{1}{12}$  parts of an inch.

		Range.	The Majority.
Internal measurement	{ Breadth . . .	4 to $6\frac{1}{2}$ . . .	4, or 5.
	{ Depth . . .	4 — $7\frac{1}{2}$ . . .	5, 6, 7.
Middle	{ Breadth . . .	$4\frac{1}{2}$ — $6\frac{1}{2}$ . . .	$4\frac{1}{2}$ , 5, 6.
	{ Depth . . .	$3\frac{1}{2}$ — $5\frac{1}{2}$ . . .	4, 5.
External	{ Breadth . . .	9 — $13\frac{1}{2}$ . . .	{ 9, 10, 11, 12, 13.
	{ Depth . . .	3 — 5 . . .	$3\frac{1}{2}$ , 4, 5.

It is thus seen that, at the internal measurement, which represents the form of the inner half, the depth usually exceeds the breadth by from one to two lines. The breadth is, however, occasionally equal to, or even a line greater than the depth. In slender specimens also, the depth usually exceeds the breadth.

At the middle measurement, at the transition part, these proportions are seen to be reversed, the breadth now exceeding the depth by a line or more. Sometimes, however, the depth is equal to the breadth or even exceeds it by half a line.

At the broadest part of the tabular portion the breadth is two to three times as great as the depth. The greatest depth and greatest breadth usually go together, and vice versa; but not necessarily, as, in some strong bones, the outer part is not very broad.

The increase of breadth, and diminution of depth, from within outwards may be shown by arranging these measurements differently, thus:—

	Internal.	Middle.	External.
Breadth . . .	4, or 5 . . .	$4\frac{1}{2}$ , 6 . . .	9, 13
Depth . . .	5, 7 . . .	4, 5 . . .	$3\frac{1}{3}$ , 5

The increase in breadth is very slight until we arrive at the outer third, at the broadest part of which it is more than doubled; and from this it again diminishes along the most external inch or half inch. But the depth does not diminish correspondingly. It diminishes most along the inner half, but along the outer half the diminution is usually very little, and sometimes there is none at all. The tapering or pyramidal form which the bone presents to the eye along its borders, is in part deceptive, as, at the outer third, it is thinner near the borders than along the middle, especially along the anterior border, owing to the bevelling at the deltoid impression. The measurements were made midway between the anterior and posterior borders, where the breadth is the greatest, and the depth here is often a little increased by the elevation of the trapezoid impression. Still, the depth at the outer part is, except at the edges, very little less than at the middle of the

bone; it is the great proportional breadth which is apt to mislead us to the conclusion that the bone is much thinner here. The depth of the acromial facet, as already stated, is  $\frac{1}{4}$  to  $\frac{1}{3}$  or even  $\frac{1}{2}$  an inch, and there is usually very little elevation of its margins beyond the level of the surfaces of the shaft, although a little is to be allowed for its obliquity.

**SIZE AT DIFFERENT PARTS.**—The diameters just given indicate the actual and proportional changes of form, but the exact size can be ascertained only by taking the circumference at different parts. The following is an abstract from a table of the circumferences of twenty specimens, including all kinds, taken at eight different parts. The first and last indicate the size of the extremities round their margin. The 2d, 3d, 4th, and 5th, are taken at distances successively of an inch, or at proportional distances when the bone is less than six inches in length. The 7th is at the broadest part of the outer third, usually less than an inch from the outer end; and the 6th is at the centre of the conoid tubercle, about  $1\frac{1}{2}$  inch from outer end. Each measurement is at the outer end of the inch to which it refers.

	Range.	Majority.
1. Sternal end, . . . . inches	$2\frac{1}{4}$ to $3\frac{1}{2}$	$2\frac{1}{2}$ to 3.
2. First inch, . . . . .	$1\frac{1}{6}$ — 2	$1\frac{1}{2}$ — $1\frac{3}{4}$ .
3. Second inch, . . . . .	$1\frac{1}{4}$ — $1\frac{3}{4}$	$1\frac{1}{2}$ .
4. Third inch, or middle of bone,	$1\frac{1}{8}$ — $1\frac{1}{2}$	$1\frac{1}{3}$ .
5. Fourth inch, or junction of } middle and outer thirds, }	same as last, occasionally $\frac{1}{8}$ inch more.	
6. At conoid tubercle, or about } $4\frac{1}{2}$ inch, . . . . . }	$1\frac{1}{2}$ — $2\frac{3}{8}$	$1\frac{3}{4}$ — 2.
7. At fifth inch, or broadest part,	$1\frac{7}{8}$ — $2\frac{3}{4}$	2 — $2\frac{1}{2}$ .
8. Acromial end, . . . . .	$1\frac{1}{8}$ — $2\frac{3}{4}$	$1\frac{3}{4}$ — 2.

We thus observe that the sternal end is always the largest part of the bone; but this is only along the edge, as the size, even of the  $\frac{1}{4}$  or  $\frac{1}{3}$  inch allowed for the extremity, diminishes rapidly immediately beyond the margin of the extremity.

The size diminishes rapidly along the first inch, at the outer end of which it is little more than half that of the sternal end.

Along the next three inches the diminution or variation is very slight; at the second, it has farther diminished  $\frac{1}{8}$ ; at the third inch, or middle,  $\frac{1}{6}$  more; and then usually continues the same to the fourth inch, just before the commencement of the flattening, as precisely indicated by the beginning of the deltoid impression.

Between the middle and the fourth inch, is the unoccupied space, or transition part. This part in many specimens has the appearance of being smaller than the bone on either side, but this arises chiefly from the difference of form. Occasionally it is  $\frac{1}{8}$  or  $\frac{1}{12}$  less, than the third or fourth inch circumference, but is usually the same. It is occasionally, therefore the smallest part of the bone, and in all there is no part smaller.

Thus, for three inches there is very little difference in the size of the shaft; and this includes the internal two-thirds of the bone, and therefore, the internal or great curvature, except the inch next the sternal end.

From the beginning of the outer third, the size increases with the increasing breadth, outwards to the broadest part, which is the largest part of the shaft of the bone, and only half an inch less in circumference than the sternal end itself. From this point it decreases both inwards and outwards; inwardly the decrease is more extensive, but is interrupted by the prominence of the conoid tubercle, at which the circumference is a little greater than at either side of it; outwardly the diminution is more or less gradual, and around the acromial facet the size is usually about the same as at the summit of the conoid tubercle.

Thus, the whole of the outer third is larger than any part of the rest of the bone except near the sternal end, and within less than an inch of it.

The inner and outer halves of the bone are of nearly equal weight. This may be ascertained by balancing the bone on the edge of a knife; the balancing point, or centre of gravity, lies very near the middle or a little internal to it, sometimes, however, as much as  $\frac{1}{8}$  or  $\frac{1}{4}$  inch.

The *relative strength of the clavicle at different parts* will be modified by form. The effect of flattening should be to make it stronger in one direction than another. If so, the outer third will be better able to resist force coming against its borders, than against its surfaces, and, therefore, be more readily broken by a direct blow from above than from before. It is doubtful what the effect of mere flattening should be as regards longitudinal force, whether it should not be more liable to break in one direction; the flattening of the outer third, however, is not accomplished by thinning, but by actual increase of breadth, while the depth remains little diminished. The inner two thirds, would seem, as far as form and size are concerned, to be about as able to resist force in one direction as another. The relative strength must also be influenced by the curvatures or bending, by the direction of the force, and by the structure, as well as the size and form, and all these circumstances may influence the position in which fracture will occur.

*Fracture of the clavicle*, as is well known, commonly results from a fall or injury upon some part of the limb, as in a fall on the shoulder, elbow, or hand, although in the latter case the radius is more likely to suffer. The force is in either case directly or indirectly received by the scapula, and thence transmitted along the clavicle, upon the sternum. This we may call longitudinal force, as it acts more or less in the direction of the bone. The effect of force thus acting is diminished by the obliquity of the articular surfaces at the acromio-clavicular articulation, as the clavicle thus tends to slip a little over the acromion, until checked by the ligaments which connect it to the acromion and coracoid processes, thus throwing the force partly upon the ligaments. The force thus sustained by the ligaments no doubt is again transferred by them to the clavicle, but, meanwhile, the direction of the force has been somewhat changed, and the shock has been much diminished by the motion, as at the ankle joint, by the slight mobility of the external malleolus; in both cases, no doubt tending much to obviate fracture. But longitudinal force is still farther diminished by the outward and backward obliquity of the clavicle. The scapula pushes the outer end of

the clavicle backwards and probably also upwards; and the force is thus in part lost, and must tell much less upon the clavicle, than if it were set horizontally between the scapula and sternum. The state of the muscles, which are usually thrown into action in the endeavour to avert or sustain the fall, may prevent much of this motion backwards, and cause a more direct transmission of the shock; but still, as the clavicle naturally lies very obliquely, part of the force must be lost in the tendency to push it backwards, whether the muscles resist or not. Fractures of the clavicle from force received at the outer end, may be caused in two ways, either simply by direct longitudinal force, or by the motion of the outer part of the clavicle going so far that it is snapped off from the less moveable internal part, which is so firmly tied down at the sterno-clavicular articulation. It is conceivable that a force in any direction might act in this latter way, tending to move the shoulder upwards or downwards, forwards or backwards, farther than the connexions of the inner end of the clavicle would allow, thus snapping the bone across. Recollecting the attachment of the coraco-clavicular ligaments, it is evident that the scapula thus acts, not merely on the outer end, but upon the whole outer third of the shaft; and we would therefore expect the bone to snap across at some part internal to its outer third. In this case the fracture might be either transverse or oblique.

If acting by the other principle—simple longitudinal force—we would expect the fracture, irrespective of the relative strength of different parts, to be at one of three places, either at the middle of one of the arches, especially the greater one; or at the transition part, which, as we have seen, belongs to both arches, and is the part where the straight and sigmoid axes intersect each other. The external third being considerably larger than the internal two-thirds (until near the sternal end), we would not expect this part to give way, and I am not aware of any facts showing that it does so in this kind of accident, although this part is occasionally broken. If the fracture occurred simply from overbending we would expect it to be situated at the middle of the internal arch—*i.e.* 2 to  $2\frac{1}{2}$  inches from the sternal end, through

the inner part of the middle third, and to be more or less transverse. But the part where we would expect the longitudinal force to cause fracture most readily, is where the straight and sigmoid axes intersect each other, and this we have seen is obliquely through the unoccupied or transition space, the outer part of the middle third. This will appear evident also in another way, by looking along the bone; the straight axis of the inner half and the straight axis of the outer third, if prolonged, run nearly parallel and leave between them this transition part; here the force has to change its direction, and here therefore we would expect it to tell and cause the fracture, just as the force along the lower extremity tells, though in a much greater degree, at the neck of the thigh bone, which is, in this respect, mechanically the weakest part of the thigh bone. If, therefore, the fracture were to result from over-bending of the greater arch, it should be at the inner part of the middle third, and more or less transverse; if where the force has to change its direction, at the intersection of the bent and straight axes, then it should be through the outer part of the middle third, and more or less obliquely. Size, or strength, can have very little influence here, as we have seen there is very little difference indeed in the circumference of any part of the middle third, although the outer part (the transition or unoccupied space) is occasionally a little smaller than the inner part. Were the fracture to occur on the principle first explained, over-motion at the outer end, snapping the bone across, we would expect it to occur at the weakest part of the bone, internal to the outer third; through some part, therefore, of the middle third. Again, these causes of fracture may be influenced by the muscular attachments; supposing the outer third to be fixed by the action of the trapezius and deltoid muscles, the pectoralis major, much stronger than the sternomastoid, would pull upon the inner half, and the strain would tell most upon the unoccupied or transition space; or, again, the sudden action of the pectoral and deltoid only would have a similar effect.

For these various reasons, but chiefly from its being the seat of crossing of the axes, the outer part of the middle third appears

to be the most likely to give way from longitudinal force, or the ordinary circumstances under which fracture of the clavicle occurs.

After arriving at this conclusion altogether irrespective of how the fact might be, I examined the specimens of united fracture within my reach, six in number, and in all of these the fracture has been through this part, the outer half of the middle third—*i.e.*, external to the middle of the bone and internal to the outer third, except in one in which it is through the inner part of the outer third. Also, the fracture seems always to be more or less oblique, and in the direction in which the straight axis crosses. The outer end of the inner portion, which forms the so-called “rising end,” may be blunt or more or less sharp, but in either case is cut obliquely on its posterior aspect. The outer fragment, besides being united usually on a lower level, appears joined to the back of the inner, which, however, is the natural result of this obliquity; and in some the bone has been much shortened, by the great obliquity of the fracture, and the external portion shifting a long way inwards behind the inner portion. These views seem to accord with the opinions of writers on surgery as to the more frequent seat of fracture, and what I have seen of the ordinary fracture of the clavicle in the living body also leads to the same conclusion, that it is usually external to the middle, the “rising end” pointing, more or less bluntly, outwards and forwards.

Fractures of the clavicle, it is well known, may occur at any part, as from a direct blow, but it is often impossible to say exactly in what way the injury occurred. All I mean to say is, that, from simple longitudinal force, the fracture is most likely to be through the outer part of the middle third, that is, a little external to the middle. Also, that the fracture is most likely to be oblique, in the direction in which, as well as at the place where, the straight axis crosses the bone, so that the outer fragment will slip obliquely in behind the inner. On the peculiarities of fractures through the outer third, it is unnecessary here to enter.

PRINCIPLES OF CONSTRUCTION AND MECHANISM.—What is

the design or meaning of the particular forms of the clavicle, at its different parts; the two extremities, the inner and outer portions of the shaft, and the curvatures?

The *sternal end* is intended to move against a shallow socket, and requires a very strong provision against displacement. Hence its size, partly belonging to the articular surface, and partly non-articular, for the attachment of the strong ligaments which tie it down.

The *acromial end* is flat. A thick or prominent form would have been inconvenient on the top of the shoulder; the clavicle and acromion process are therefore flat; and what was wanted at this joint was rather a point against which the scapula could rest and play, strength of union and provision against displacement being secured by the ligaments from the coracoid process.

The *outer third* of the shaft is flat. As with the acromial end, this is more convenient as it approaches the prominence of the shoulder. It is necessary for the continuous attachment of the conoid and trapezoid ligaments, which, as we have seen, extends obliquely across the whole breadth of the under surface from the posterior to the anterior border. The portion behind the line of the trapezoid attachment is required for the attachment of the acromio-clavicular ligament on the outer and back part of the upper surface. Also, the outer third gives attachment above to the deltoid and trapezius muscles, but these do not usually occupy the whole breadth, and, if it may be so expressed, might have arisen as well from a rounded or square as from a flat or broad portion, had the flatness not been required for the purposes above mentioned. The breadth of the outer third is thus accounted for; its depth or thickness is necessary, to give sufficient depth for the acromial facet, and also to give this part of the bone sufficient strength. There is considerable strain upon this part; the deltoid and trapezius muscles pull by its upper surface, and below, the conoid and trapezoid ligaments tie up the coracoid process to it, as it were suspending the shoulder thereby.

Along the *inner two-thirds*, it is thick, not much more flattened in one direction than another, is bent with the convexity forwards, increases in size inwards, and has a cylindrical form

modelled into certain borders and surfaces. The increase in size, inwards, is not considerable till we approach the sternal end, towards which it gradually rises; without this, the head would have been an abrupt swelling, receiving the force unequally. The rhomboid impression also contributes to the size of the internal inch. The curve, having its convexity forwards, evidently gives an important protection to the great nerves and blood-vessels passing from the neck to the axilla, besides rendering the bone more able, for its own sake, to resist blows from before. It is not required to be flat here, and to have been so in either direction, would have been as awkward as to have been rounded at the outer part; the cylindrical form serving better, for strength, for the arch, and for the muscle. As to its surfaces, we notice, first, that the posterior is always unoccupied; it is part of the wall of the bone, required as a beam to keep out the shoulder, but of this side of the wall no farther use is made. The inferior surface is narrow, but broad enough for the attachment of the rhomboid ligament and subclavius muscle. The anterior aspect furnishes attachment to the pectoralis major and sterno-mastoid muscles, but it does not appear that these muscles require the inner half of the bone to be cylindrical or arched. We notice, however, that the posterior or unoccupied surface is the flat one, and the anterior surface vertically the convex or prominent one, thus giving most space where it may be useful for the pectoral muscle. The various degree of flattening of the impression for the pectoral muscle is unimportant as regards general construction.

These various considerations seem to explain, or imply the existence of, *the curvatures*, but they may serve the additional purpose of enabling the elasticity of the bone to come into play, and assist in diminishing shock. This has been well shown by Mr Ward, in his excellent treatise on the bones; that a smart blow on the end of a clavicle standing erect, will make it spring to a distance of nearly two feet; and that, if struck on the convexity of its great arch, when lying horizontally, it will spring from the floor to a height of about a foot. Elasticity belongs to all bones, in virtue of their animal constituent, and is best

seen when the mineral constituents have been more or less removed by acid; but it is not proved that the clavicle exceeds other bones in elasticity. Curvature can merely enable the elasticity to come more easily into play, just as a piece of bend-wood already in the form of a bow, will begin to bend more readily than a straight piece; though it will not bend farther, from where it began, than a straight piece, without breaking. The advantage, therefore, of curvature, whether single or double, is by facilitating the occurrence of little yieldings, to diminish the abruptness of shock or concussion, and avert the consequences thereof, not to obviate fracture. If anything, indeed, it would rather render fracture more easy, as it renders bending more easy. It may be said, whatever diminishes shock, will tend to obviate fracture, but when fracture occurs from simple transmitted shock, it is when the part is so brittle, as the petrous portion of the temporal bone, or brittle and mechanically weak as the cervix femoris in elderly persons, that bending in either case is out of the question, from the small quantity of animal matter in the part, or the bone, or skeleton generally. When we say the clavicle breaks from the shock of a fall on the arm, it is not meant that it has not first yielded or bent; unless it is brittle, it must first bend, and then break when the force is too great to be resisted, and curvature, in facilitating the one, will also facilitate the other. We are here, it must be recollected, not considering whether an elastic bone will break less readily than a brittle one (which will be the case under all circumstances), but whether two bones of the same elasticity or brittleness, one straight, the other curved, will break most readily, under a force acting longitudinally. Of course, when a blow falls directly on a bone, horizontally, a straight one will give way more readily than a curved one receiving the blow on its convexity. An intermediate stage is sometimes seen in young persons, where the injury produces a fixed bend, without fracture proper or separation. I have seen the clavicle of a boy much bent in this way; and also both radius and ulna, in a boy six years of age, much bent to one side; and have bent them back again. There must, however, in this condition, be partial fracture or crushing of the

structure of the bone, and the bending back again may be attended by a crackling noise.

The mere curving of the clavicle, then, does not confer elasticity, nor in any way obviate fracture from longitudinal force; but it enables the elasticity to come into play and make itself useful, under natural forces, by slight bendings or yieldings, which serve the purpose of somewhat diminishing shock. This, however, is principally obviated by the obliquity of the bone, and the mechanism of the articulations at both ends, as already explained.

The following propositions may be laid down on this subject:—(a) Without any elasticity, a curved bone will break more readily than if it had been straight, giving way where the change of direction occurs. (b) The addition of elasticity to any kind of bone will tend to obviate fracture, as, instead of breaking, it yields, and will recover itself unless the force is too great. (c) With equal elasticity, a curved bone will bend more easily than a straight one—*i. e.*, it is less able to resist force, or is weaker, and will therefore overbend, and at last break, more readily; so that, as regards strength, curving is rather disadvantageous to an elastic as well as to a brittle bone. (d) The only advantage, therefore, of curving in an elastic bone, is that, under natural forces, the more ready yieldings are useful in diminishing unpleasant concussions.

This then is an advantage of the curvatures, whether it be their primary design or not, but they seem to be provided primarily for other purposes. The great internal curve evidently serves a most important purpose in protecting the great vessels and nerves against injury from before. This is a very sufficient reason for the internal two-thirds being arched with the convexity forwards; besides, had the bone gone straight out from the sternal end to above the coracoid process, there would have been less room between it and the first rib for the vessels and nerves to pass. It was next necessary that the bone should lie above the coracoid process and then turn forwards to meet the acromion; and by its anterior concavity it is sunk in to the hollow in front of the shoulder, out of the way of injury. These

considerations appear sufficient to account for the external curve; first sinking back, both to be out of the way of injury and to reach the coracoid process, and then turning forwards to meet the acromion. Thus the internal or great arch would seem to be laid down across the neck primarily as a protecting arch against direct force, and being elastic so much the better, whilst the external curve would seem to result from other necessary arrangements. In addition, however, whether primarily so intended or not, they must act in diminishing the shock of longitudinal force as above explained. In many situations we find several results secured by one and the same arrangement, all equally primary in the divine foreknowledge and purpose; and the one which appears to us, the interpreters, as of the greatest importance, we call primary.

STRUCTURE.—The shaft is composed of a tube of dense or compact tissue, filled with coarse spongy texture; the extremities principally of spongy texture, covered in by a thin layer of the dense texture. The statements of writers differ as regards the existence of a medullary canal in the clavicle. I have never seen it. When the bone is sawn across, as is usually done in removing the limb from the trunk, the coarse spicula which fill the interior are apt to be broken down by the saw or point of the finger, and thus give the appearance of a hollow or canal, but a series of longitudinal sections, made both horizontally and vertically, will show that, whether in the young or adult bone, the interior is filled up by a spongy texture. What some mean by medullary canal, may, however, merely be that there is a wall or tube of dense texture, as in the shafts of the long bones, without considering how this is filled up; and the spongy texture is certainly much coarser and less spongy-looking than at the extremities, or than spongy tissue in spongy bones proper. In some specimens also, it seems much more open in the middle third than in others, and I do not doubt but that a short space might occur about the middle, without spongy texture, which, if the bone was there sawn across, would mislead to the conclusion that a medullary canal existed.

The *dense texture* forms a thick wall along the greater part of the shaft, from  $\frac{1}{12}$  to  $\frac{1}{8}$  inch in thickness, or even sometimes  $\frac{1}{6}$ . In the latter case the spongy tissue at the middle is not broader than the section of the wall on one side, but it is usually twice as broad, and sometimes still broader, the tube of denser texture then gaining size of cavity at the expense of the thickness of its walls. I am inclined to consider the latter condition the natural change of age on the long bones, rendering them lighter and more shell like, but the question of the effect of age and other circumstances on the relative arrangement of cancellated and dense textures will be considered fully with the long bones of the lower extremity.

The dense layer begins to diminish, internally, about an inch from the sternal end, but still forms a layer of considerable thickness until it turns round the edge to the sternal face, over which it forms the usual thin articular lamina. Externally, it begins to thin earlier, at least on the convexity of the curve, about  $1\frac{1}{2}$  inch from the acromial extremity. It diminishes as the bone increases in breadth, and from the broadest part of the bone, to the acromial facet, about the last  $\frac{1}{2}$  or  $\frac{3}{4}$  inch, it is very thin; especially behind, it is little if any thicker than the thin articular lamina of the acromial facet.

The dense layer is thicker on the concavity than on the convexity of each curve. This appears to be always the case, and usually to a very marked degree, especially with the external curve. At the middle of each curve, it may be a half more, or twice or three times as much. Along the outer curve, the thinness on the convexity may be explained by the greater depth or thickness of the bone here than in front, requiring opening out into spongy texture—the usual way in which bulk is obtained; but the difference exists along the whole of the internal curve also, and is evidently a special provision to strengthen the concavity of the curves. Another view to take of the object of this provision, is, that it gives greatest strength in the direction of the straight axis, which is much nearer the concavities than the convexities of the curves; and thus, at each bend, the spongy texture is obtained at the expense of the convexity, the part

farthest removed from the straight axis. From this greater thickness along the concavities, it results that the dense tissue, in thinning towards the extremities, is continued nearer to, or is more marked towards, the fore part of the acromial end and the back part of the sternal end.

The *cancellated or spongy tissue* is different at the extremities and the shaft. At the sternal end, there is about an inch of fine spongy texture; the laminae or spicula at first come off obliquely from the thinning dense texture, but soon lose this inward direction, and cross in all directions, and the intervening cellules are rounded, and not more elongated in one direction than another. They are, however, smaller and closer along the inner half inch; and  $\frac{3}{4}$  inch or a little more from the end, just before the fine spongy tissue ceases, they become more open, and the spicula more delicate, and easily broken down. Towards the acromial end, the laminae and spicula, as they arise from the compact wall, are larger, and chiefly directed outwards with an inclination towards each other as if to meet in the axis. The intervening cellules have a corresponding elongation or direction outwards, the majority pointing towards the posterior end of the acromial facet; but near the facet they all become smaller and run at right angles against the articular lamina. Along the shaft of the bone the laminae and spicula are fewer and stronger, and may be seen to run more or less obliquely across the tube, from its posterior to its anterior wall, outwards and forwards between its two concavities, and, therefore, in the direction of the straight axis; but in some sections this is not apparent, the laminae running nearly parallel to both walls of the tube, like a series of horizontal shelvings, united by oblique or vertical portions, so as to form a series of large cellules, elongated more or less obliquely or horizontally outwards.

The internal structure does not appear to exert any influence in determining the situation of the ordinary fracture. The transition part, belonging to the concavity of both arches, is not deficient in thickness of dense wall. We thus see that, in structure, the clavicle is intermediate between a rib or the flat bones generally, and the long cylindrical bones, and resembles the

short, cylindrical bones—the metatarsal and metacarpal. It has the wall or tube of dense tissue, and yet has no medullary canal, or to express it in another way, what would otherwise have been the medullary canal is filled up by spongy tissue; in the cells of which the marrow is laid, instead of forming one continuous mass. Supposing the tube to be of the same size and thickness, the bone must be stronger by this arrangement, as it has the spongy tissue instead of nothing.

VARIATIONS WITH SEX AND SIDE OF BODY.—*Sex.* There is no necessary or constant difference between the male and female clavicle, but in the female it is generally less curved, smoother, more slender, and shorter. We have already seen that it is by no means necessarily less curved in the female, being not unfrequently more curved than in many male specimens, and in some as well curved as in any males. Also, in the female as in the male, the amount of curving does not by any means increase with the thickness or roughness. We therefore cannot say that the female clavicle is usually less curved because it is usually less muscular; the two conditions are usually combined in the female, but not as cause and effect. The less length in the female contributes to the narrowness of the shoulders, to which the apparently greater obliquity of position also contributes. The roughness and thickness no doubt correspond, whether in the male or female, to the muscular development, and hence the female clavicle is usually more smooth and slender. The difference is usually very striking. A characteristic male clavicle will balance, or even weigh down, a pair of characteristic female specimens.

*Side of body.*—The right clavicle is generally thicker, heavier and rougher than the left; for the same reason that they are usually thinner and smoother in the female than the male. M. Cruveilhier mentions that by noticing a greater size of the sternal end on the left side, he predicted correctly that the individual was left handed. In general, however, the difference as seen on the skeletons, is not striking, though apparent enough on careful examination. This increase under use, or from laborious occu-

pation, does not appear to affect the clavicle more than the other bones of the extremity, although it seems to affect the upper more than the lower extremity, for instance, the humerus more than the femur.

The right clavicle is occasionally, if not frequently shorter than the left, in two instances I have found the difference as great as  $\frac{1}{3}$  inch. This may occur in the female, but most of the instances I have met with are in muscular males. The curves do not then appear to be greater, so as to account for the shortness, but the shorter bone is the thicker of the two.

The greater thickness or bulk of the right clavicle is apparent to the eye on careful comparison, and may be ascertained by measurement of the circumferences, it is most apparent at the sternal extremity, and at the broadest part near the acromial extremity, but exists throughout the bone. It will be recollected also, that the prominence of the ascending portion of the semilunar notch of the sternum is usually very distinctly more developed on the right side.

We would expect a corresponding difference in *weight*. I lately prepared eight pairs of clavicles, taken indiscriminately from the subjects in the rooms, the right and left of each being subjected to exactly the same preparation, and, on weighing them, I find the right to be the heaviest in five, the left in three, and in one they have precisely the same weight. In the latter case, they are from a male subject æt. 52; the right has a decided appearance of greater bulk than the left, especially along the inner half and at the sternal end. Of the three in which the left is the heaviest—one is from a male subject æt. 36; the right has no decided appearance of greater bulk than the left, and the left is the heaviest by only half a grain. The second, from a muscular male æt. 23, the left is the heaviest by 9 grains, and it looks larger and measures a little more, at least at the sternal end. The third, from a thin female æt. 23, the left is the heavier by 16 grains, and longer than the right by  $\frac{1}{3}$  inch, but the right has the largest sternal end. The right scapula from the same subject is, however, decidedly heavier than the left. In the previous cases I had no opportunity of comparing the scapulæ.

Of the four in which the right is the heaviest—in one, from a muscular male æt. 48, the difference is 19 grains. The second, from a male æt. 60, the bones not so thick as the last but more curved, the difference is 7 grains; and in both of these, but especially the second, the right clavicle is shorter than the left. In the third, from a thin female æt. 77, the bones well marked but light, the difference is 11 grains—equal to a fourteenth part of the entire weight of the right. And in the fourth, from a female æt. 42, the right is the heavier by 30 grains. The scapulæ were also preserved from this subject, and the right is much heavier than the left.

These facts seem to point to contradictory conclusions, but can be said only to show that greater size does not necessarily imply greater weight. Weight must depend on the amount of osseous tissue, irrespective of whether it is condensed into little bulk, or opened out into spongy tissue. A large shaft may be given, here or elsewhere, without additional bony matter, by thinning the wall as the tube enlarges; and the expansion at the extremities of the long bones, we know is effected by as it were the opening out of the compact tissue, which gradually diminishes as the spongy tissue is developed. While the right clavicle would seem to be most frequently also the heavier as well as generally the larger, it is curious to notice that the facts showing that it is not necessarily so, show farther that the reverse may be the case—that the larger bone may be not only not the heavier but the lighter. We can scarcely suppose that three out of eight subjects had been left handed, especially as in two of three, the right though the lightest, was the largest.

#### SUMMARY OF MUSCULAR ATTACHMENTS.

*Pectoralis Major.*—To inner half of clavicle; lower division of superficial or anterior surface (pectoral impression). Externally, reaching to middle of clavicle; internally, to  $\frac{1}{4}$  inch from articular margin. Usual length 2 to  $2\frac{3}{4}$  inches, usual depth at middle  $\frac{1}{3}$  inch. Entire attachment fleshy.

*Sterno-Mastoid.*—Along internal third or fourth of superior

border, (sterno-mastoid impression). Length,  $1\frac{1}{2}$  to  $1\frac{3}{4}$  inch; most internal part  $\frac{1}{4}$  or  $\frac{1}{2}$  inch, and most external part  $1\frac{3}{4}$  to 2 inches, from margin of sternal end. Breadth, not exceeding  $\frac{1}{4}$  inch, outer part thinner. Attachment by two ranges, anterior aponeurotic, in front of border, posterior fleshy and aponeurotic to border proper and upper part of posterior surface.

*Deltoid*.—To outer third of superficial surface, usual length  $1\frac{3}{4}$  inch; usual breadth  $\frac{1}{4}$  inch at middle, or about anterior third of breadth of this surface (deltoid impression). Outer end close to outer end of bone, and deepest fibres to anterior border, not below it. Attachment fleshy, with tendinous bundles.

*Trapezius*.—Opposite deltoid, to posterior third of breadth of superficial surface, (impression for trapezius); also down behind superior border, to narrow posterior surface of tabular portion. Usual length  $2\frac{1}{2}$  inches; longer than deltoid because it is along convexity; both begin opposite junction of middle and outer thirds. Outer inch, along posterior border, attached rather upon acromio-clavicular ligament than directly to bone. Attachment aponeurotic in front and especially externally, behind fleshy. Deltoid and trapezius cover anterior and posterior thirds of superficial surface; subcutaneous space between, often less than a third of the breadth, but broader internally as muscles narrow.

*Subclavius*.—To inferior surface, occupying about middle half of clavicle (subclavian impression). Begins  $1\frac{1}{4}$  inch from sternal end, terminates  $1\frac{1}{2}$  or  $1\frac{1}{4}$  inch from acromial extremity, usual length 3 inches. Breadth internally  $\frac{1}{8}$  or  $\frac{1}{6}$  inch, externally  $\frac{1}{3}$  inch; this being nearly whole breadth of inferior surface, except narrow part in front, at least externally. Attachment by concealed line of tendon or aponeurosis, and fleshy behind and in front of this. Surface at outer  $\frac{2}{3}$  of insertion usually somewhat grooved.

*Sterno-hyoid*.—Highest fibres of origin usually from back of clavicle, close above inner part of inferior border or rhomboid impression, half an inch in breadth. Sometimes even highest fibres come only from ligaments below this. No mark on clavicle for this muscle.

## SUMMARY OF LIGAMENTOUS ATTACHMENTS.

To sternal extremity. *Inter-clavicular* ligament to superior angle. *Posterior sterno-clavicular ligament* to posterior angle, and border between superior and posterior angles. Also to posterior angle, a posterior costo-clavicular band. *Anterior costo-clavicular* ligament, to border between superior and anterior angles. To anterior angle may be attached an anterior costo-clavicular band. These various ligaments run outwards on the extremity for  $\frac{1}{4}$  to  $\frac{1}{3}$  inch, so as to have greater breadth of attachment. *Inter-articular fibro-cartilage* or *disc*, to upper part of sternal face; attachment crescentic (ligamentous crescent), from before backwards  $\frac{3}{4}$  inch, vertically  $\frac{1}{4}$  inch at middle just at and below superior angle, being here continuous with fibres of inter-clavicular ligament. May reach farther behind than before superior angle.

*Rhomboid* or great costo-clavicular ligament, below internal fourth or fifth of clavicle; begins close to articular margin, a little in front of posterior angle; reaches out for 1 to  $1\frac{1}{4}$  inch; breadth or thickness  $\frac{1}{4}$  inch, more or less, but outer third usually much thinner. Attached to well-marked impression (rhomboid impression).

To acromial extremity. *Superior acromio-clavicular* ligament, to outer part of upper surface and posterior border, increasing in breadth backwards (ligamentous impression); extending upon the bone in front  $\frac{1}{4}$  or  $\frac{1}{3}$  inch, and behind and along posterior border  $\frac{3}{4}$  inch or even an inch. Entire attachment about an inch in breadth, from before backwards. *Inferior acromio-clavicular ligament*, very weak, especially at middle; attached close to lower edge of acromial facet, not extending outwards on inferior surface.

To under surface of external third of shaft, the *coraco-clavicular* ligament, conoid and trapezoid portions having one continuous crescentic attachment. *Conoid* (to conoid tubercle or impression) begins 2 inches inwards from acromial extremity, at or near posterior border, and reaches  $\frac{3}{4}$  inch to an inch outwards

and forwards; breadth at middle  $\frac{1}{4}$  to  $\frac{1}{3}$  inch, but thinner internally. *Trapezoid* (to trapezoid impression), prolonged from conoid, forwards and outwards; length also  $\frac{3}{4}$  inch to an inch; breadth of attachment increases forwards to  $\frac{1}{2}$  inch, owing to great obliquity of fibres of ligament; terminates externally close to anterior border, and here and behind this, is  $\frac{1}{3}$  to  $\frac{1}{2}$  inch from acromial extremity. Thus, there is one continuous attachment (to crescentic ligamentous impression) below outer two inches, or outer third of bone, except outer  $\frac{1}{2}$  or  $\frac{1}{3}$  inch; crossing obliquely outwards and forwards from posterior to anterior border; the concavity of the crescent forwards; and the average breadth or thickness  $\frac{1}{3}$  inch.

*Lately Published, by the Same Author, Price 5s.,*

# ANATOMICAL AND PHYSIOLOGICAL OBSERVATIONS;

CONTAINING PAPERS ON THE FOLLOWING SUBJECTS:—

1. On the Supra-Condylloid Process.
2. On the Oblique Muscles of the Eye in Man and Vertebrate Animals.
3. On Double Stomach in Man.
4. On the Nerves of the Orbit.
5. On Open Foramen Ovale and the Fœtal Heart.
6. Case in which the Pulmonary Artery gave Origin to the Descending Aorta and Left Subclavian.
7. Anatomical Inquiry into the Mode of Action of Local Blood-Letting.
8. Dissection in a Case of Paralysis of the Common Motor Oculi Nerve.
9. Description of an Esquimaux Female Pelvis.
10. On the Semilunar Valves of the Heart.
11. On Rudimentary Ribs.
12. On Branches from the Fifth Pair of Nerves to the Muscles of the Eye.
13. On Diverticula from the Small Intestine.
14. On Various Points in Anatomy, considered in a Review.
15. On the Abnormal Anatomy of the Arm.
16. On the Fascia of Scarpa.

---

EDINBURGH: SUTHERLAND AND KNOX, 60, SOUTH BRIDGE.

1841

# athologische Histologie

LEHRBUCH

Geodachmann und die Histo-Pathologie

Lehrbuch der Histologie

Dr. Theodor Billroth

Berlin