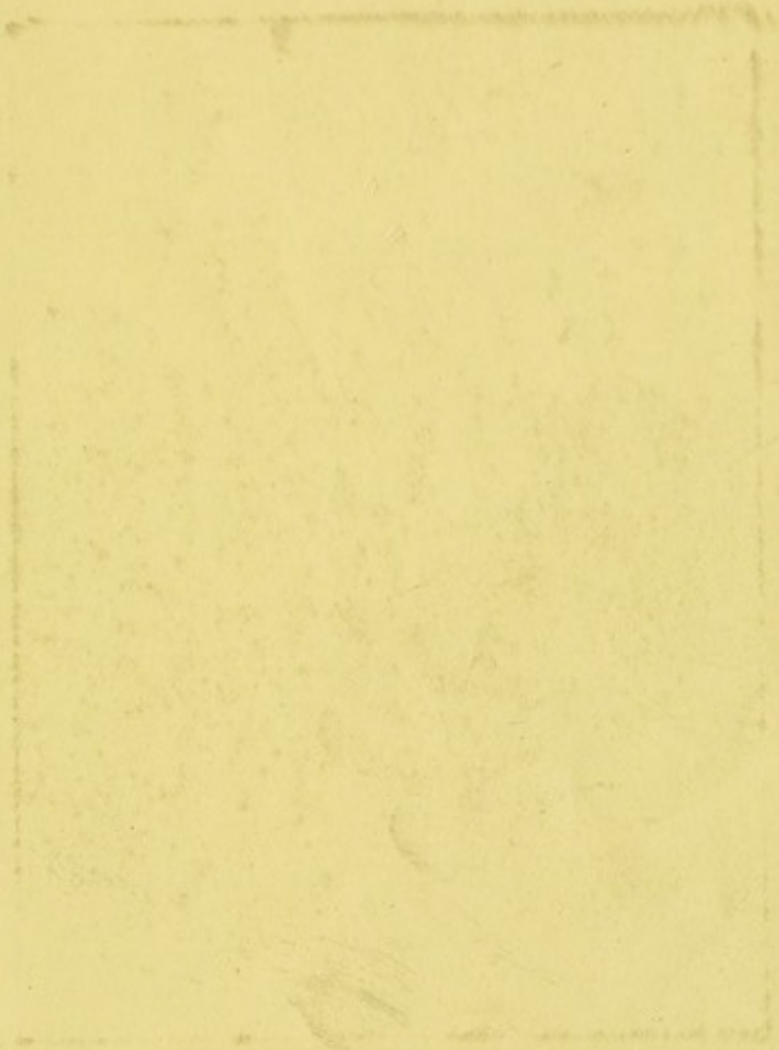
Osteotomy and osteoclasis for deformities of the lower extremities / By Charles T. Poore.



OSTEOTOMY

AND OSTEOCLASIS

FOR

DEFORMITIES OF THE LOWER EXTREMITIES.

BY

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1884.

TO THE MEMORY

OF

MY UNCLE,

CHARLES N. TALBOT, Esq.,

THIS VOLUME IS DEDICATED,

AS A SLIGHT TRIBUTE OF AFFECTION, GRATITUDE,

AND RESPECT.

PREFACE.

The author of this volume has had considerable experience both in the mechanical and in the operative treatment of the deformities considered in this book.

That there is a want of a concise treatise on osteotomy—one in which the methods of operating and the management of the wound and limb after section are considered—there can be no doubt. Whether the author has succeeded in this purpose the reader must determine.

Much time and reading have been devoted to its production, and he trusts that his labors have not been entirely in vain. Very free use has been made of Dr. Macewen's excellent work on Osteotomy, as well as of Campenon's thesis "Du redressement des membres par l'ostéotomie," and for which the author desires to express his indebtedness.

He is also under great obligations to his friends Dr. W. T. Bull, Dr. V. P. Gibney, Dr. F. Lange, of this city, and to Dr. E. H. Bradford, of Boston, for

valuable assistance; to Dr. A. T. Cabot, of Boston, Dr. E. M. Moore, of Rochester, and Dr. R. H. Wharton, of Philadelphia, for the use of specimens and wood-cuts; to the Librarian of the New York Hospital Library, and that of the Academy of Medicine, for aid in looking up references; and to the publishers for the trouble they have taken to meet his views.

CHARLES T. POORE.

5 WEST THIRTIETH STREET,
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OSTEOTOMY.

CHAPTER I.

THE RELATION BETWEEN RICKETS AND CERTAIN DEFORMITIES OF THE LOWER LIMBS.

MANY of the deformities of the lower limbs whose treatment is considered in this volume have their origin in rickets. It has therefore been thought best to devote a short chapter to this disease, and to point out its connection with the subject under consideration.

Those who are connected with our large dispensaries are well aware of the prevalence of rickets among the applicants for medical aid. Whether it is as common in this country as in certain parts of Europe is doubtful. It is not alone confined to the children of the middle and lower classes, but is met with among the offspring of the wealthy, not perhaps in its more advanced stages, yet sufficiently well marked to be easily recognized if its manifestations are carefully looked for. It is seen among children who have been brought up in the country as well as those who live in crowded cities, but to a much less extent. It is a disease that merits the careful attention not only of the surgeon, but of the general prac-

titioner, in order that its results, in deformities of the long bones and changes in the shape of the chest and pelvis, may be prevented. Rickets is not a disease of the bone alone, but is a constitutional affection, attacking the osseous structures in common with every other tissue of the body. It is essentially a disease of malnutrition. It may be congenital, but it usually first manifests itself in children from six months to three years of age. Bad air, improper food, and scanty clothing are its most prolific causes. Any child may become rickety, no matter how healthy it may have been at birth, if placed under any condition that interferes with its assimilative powers. It may be laid down as a rule that a healthy child, fed on good mother's milk, will never develop this disease. It is equally true that not every child who suffers from malnutrition will become rickety. Its beginning is insidious, with the ordinary symptoms of improper digestion. The little patient may be plump, but its muscles are flabby and its complexion pale and unhealthy; large veins are distinctly seen through the pasty-looking skin. The bowels may be loose or confined, more often capricious, a day or two relaxed, then followed by a period of constipation; the stools are white, curdy-looking, and extremely offensive; the food is often passed through the alimentary canal undigested. Accompanying this derangement of the digestive apparatus there is profuse sweating of the head, neck, and upper part of the chest, worse at night. The moisture will be seen standing in large drops upon the forehead, and often runs down the face, and at night the pillow is drenched with it. While the head and neck are thus

bathed in perspiration the abdomen and lower limbs are dry and hot. Another symptom is the desire of the child to keep cool at night. It constantly throws the clothes off from its feet and limbs, no matter how cold the temperature may be. The child soon loses its activity, and seems only happy when left alone. It will sit for hours almost motionless, is petulant, and cries on being moved. The desire to be let alone is due to tenderness, more or less marked, of the bones, so that any pressure on them is painful to the little one, and it dislikes to be handled.

Dentition in those affected with rickets is usually retarded, or, if the teeth have made their appearance, they soon become black and fall out, or are early attacked with caries. Jenner states that if the ninth month passes without the appearance of a tooth, the cause should be carefully inquired into, and will almost always be found in rickets. According to Eustace Smith, the symptoms of rickets seldom appear before the fourth, and usually not until the seventh month. Cases, however, occur in which the advent of the disease is delayed much longer. Jenner mentions a girl of nine years of age in whom the symptoms of rickets had just commenced.

Enlargement of the spleen, liver, and of the lymphatic glands in different portions of the body is a common accompaniment of this disorder. In some cases the patient is reduced to a skeleton, while in others, as mentioned before, it retains its plumpness.

While the symptoms mentioned above are manifesting themselves, changes are taking place in the bones, perhaps not more profound, yet more noticeable than in any other structure of the body. One

of the earliest of these is a beaded appearance at the sterno-costal junction and an enlargement of the epiphyses, especially those at the wrist-joint. If a child affected with rickets be carefully examined, a line of nodules will be felt, and often seen, marking the point of junction between the ribs and the sternum. This condition has been noticed in children suffering from rickets six weeks after birth. When this beading of the ribs is found, it is a positive proof of the existence of this disease. There are also certain alterations in the occipital bone, often found at a very early stage of the disease in young children. Macnamara states that they are almost as constant a condition in this disease as the abnormalities of the ribs, but they are not as easily detected. If the occipital bone be carefully examined in young infants affected with this disease, there will often be felt several small, round, or oval soft spots, situated within the sutural margins of the occipital and parietal bones. These spots are unossified portions of the structures from which the bone is produced. The number of these spots varies considerably. The occipital bone is often remarkably thin in cases of this disease, and the head has a peculiar elongated appearance, while the face in marked cases remains small. (Macnamara.)

While these changes are going on, others of as marked a character are taking place in the ends and shaft of the long bones. The epiphyses become enlarged, and the shaft softened so that it is often bent, and the epiphyses may become twisted, according to the intensity of the disease and the force acting on the plastic bone. The condition of the bones varies with the stage and the intensity of the disease, and

whether the brunt of the changes falls upon the epiphyses or the diaphyses. At first the bones may be soft, so that they can be bent like cartilage; later they become very hard and deformed.

The pathological changes taking place in the bones are well described by Macnamara in his work "On Disease of the Bones and Joints." He says: "If a rickety bone be divided longitudinally during the first stage of rickets, the medulla filling the central canal and cancellated tissue will be found to be of a crimson color and jelly-like consistency, this soft medulla being especially abundant at the line of the junction between the diaphysis and epiphysis. The medulla of a child suffering from the first stage of rickets consists of a vast number of round cells, compound cells, and fat; the adenoid tissue and vessels are normal in appearance; in fact, *the elements characteristic of healthy medulla* are present in the bones of infants suffering from this disease, but there is an imperfect formation of the calcareous skeleton of the bones, and in its place we find an excess of medullary tissue. . . . The malady, so far as the bones are concerned, depends on the deficiency of earthy matter contained in this hyaline matrix. If a section made through the epiphysis into the diaphysis be examined during the first stage of the disease, there will be found at the line of ossification numerous villous-like processes of medulla, projecting, as it were, from the diaphysis into the epiphyseal cartilage. These processes, however, are not formed from the growth of the medulla of the diaphysis into the cartilage, but from a transformation of the cartilage-cells of

the epiphysis into medullary tissue at the normal line of ossification. The mass of the descendants of the cartilage-cell forming the processes referred to are incapable of producing healthy bone, in consequence of a deficiency of the bone-earth. So long as an infant is insufficiently supplied with, or is incapable of assimilating, elements necessary to the calcification of the cartilage-cells, it is impossible that healthy bone can be produced."

The changes in the shaft of the long bones, according to Virchow, "consist in the non-solidification of the fresh layers as they are formed, while the old layers of bone are consumed by normally progressive formation of medullary cavities. The periosteum is thickened and more adherent to the bone. Medullary spaces and vessels are met with where normally and properly not a single medullary cell and scarcely a single vessel ought to be found."

During the height of the disease, when the changes in the bones are marked, they can be bent by the least possible force, and their spongy portions may be easily cut with a knife. In rickets the ligaments are often altered in their structure, so that they may become easily elongated, and thus permit lateral motion in joints in which normally it does not exist. However profound the changes in the bones may have been, as soon as the child begins to masticate and is able to assimilate proper nutriment, the vast number of bone-cells rapidly take up the earthy salts from the blood, and very dense bone is speedily produced, so that in a short time the bone may become very hard. Again, the process of sclerosis may be much slower, depending

upon the power of the child to assimilate, and the quality of the food furnished. Rachitic changes in the osseous structure do not always take place in all the bones of the skeleton in equal degree, nor in every portion of an individual bone. Thus softening may be more marked at the epiphysis while in the shaft it is slight, or the shaft may show more advanced changes than the articular ends. The enlargement of the epiphyses is not an index of the changes in the shaft. The bone of one limb may be quite soft while that of the other is hard. I have met with this condition quite frequently in operating; one tibia has been found very easy to divide, while in the other section was difficult. The fibula has been found to be much harder than the tibia in the same limb.

Perhaps the existence of different deformities may be due in part to this irregularity in the portion of the bone on which the intensity of the rachitic process falls.

All writers on this disease divide it into a preliminary stage, one of softening and one of sclerosis. It is in the latter that the bone-cells take up from the blood the earthy matter that gives bone its hardness. It will be evident that this stage can not begin until the child is able to digest and assimilate appropriate food. No rule can be laid down as to the length of time that the soft stage of rickets lasts, nor the rapidity with which the hardening may advance. Each case must be judged by itself. The general health, ruddy appearance, and firm condition of the muscles are the best guide. It may take many years in children of low vital powers for

the bones to become firm, while in others it may be accomplished in a few months.

There is a condition described by some observers (Barlow, Page[1]), as "acute rickets." It occurs in children under two years of age. There is profuse sweating about the head, changes in the epiphyses, and other symptoms usually found in rickets, together with swelling and great tenderness of the lower extremities, due, it was supposed, to an effusion of blood under the periosteum and between the deeper muscular layers. Barlow considers it a combination of rickets and scurvy. By change of diet, fresh air, and compression of the limbs, recovery may take place rapidly.

The age beyond which rickets is not developed is uncertain, but probably in the vast majority of cases not after the fifth year. Some writers consider that this disease may be developed between the twelfth and twentieth years; that is, during the period of rapid growth. Macewen is an advocate of this late appearance of rickets. But it is denied by the majority of writers. In the chapter on genu valgum the cases of Macewen are given. I have never met with a case, and I think if they ever occur it must be exceptional. Deformities about the knee-joint are sometimes developed in persons from twelve to twenty years of age, but I think that their cause can be explained without attributing them to rickets. In the cases that I have had the opportunity to examine there was absolutely no symptom of rickets except the bending of the bone at the epiphyseal line. Most of the deformi-

[1] "Brit. Med. Jour.," March 31, 1883, p. 619.

ties of the lower limb are developed during the period of rapid growth. They are met with first in infantile life, when all the nutritive processes are at their height, and the child rapidly increases in weight and stature. This period, as a rule, does not extend beyond the seventh year. Then comes a time, extending from the seventh to the twelfth year, during which growth is much slower and deformities are seldom developed. From the twelfth to the twentieth year is another period of growth and development during which the long bones rapidly increase in length by the deposit of osseous material at their extremities, and which is finally completed by the consolidation of the epiphyses and diaphyses. In this period, again, certain deformities, especially about the knee-joint, are developed in those who are compelled to labor hard and undergo fatigue.

During the first period bending of the shaft of the long bones, with the consequent deformities, are common, while in the last period deformities having their origin near the joints are met with, and curvatures of the shaft of the bones are seldom if ever seen.

The connection between rickets and deformities of the bone is one of cause and effect. I do not think that the muscles exert an active influence, but that position and weight are the cause of the abnormal shape of the bones.

In this very imperfect review of the symptoms of rickets, as it affects the bones of the extremities, nothing new is claimed, the object being simply to call attention to this most prolific cause of deformities.

While the bones are soft, any abnormal change in

their shape can, and should, be corrected by appropriate apparatus. But after sclerosis has taken place, or even is well advanced, orthopedic appliances will not correct. I am not a believer in the spontaneous cure of bending of the long bones. We often hear the advice given to mothers by members of the profession not to submit these cases to treatment; that the child will "outgrow" the malposition; and I wish to enter a protest against such advice, as it will only lead to disappointment.

CHAPTER II.

OSTEOTOMY.

"Osteotomy," says Macewen, "in its broadest acceptation, may be defined as a section of bone. It has, however, been regarded in a much more restricted sense, the term being applied to such divisions of bone as have been proposed and undertaken for the relief of deformity, for the rectification of badly united fractures, and for the straightening of limbs affected with osseous anchylosis, which are fixed in a bad position." ("Osteotomy," p. 37.)

Section of the long bones for deformity had been proposed by many early writers on surgery, yet it does not appear to have been put in practice until 1815, when Le Mercier made a section of the tibia with a saw for a badly united fracture of that bone; and in the following year Wasserführ practiced the same operation upon the femur. Barton, in 1826, performed an osteotomy just below the trochanter major for anchylosis with flexion of the thigh, through an open wound, the division being made with the saw. In 1834 Clémot removed a wedge-shaped piece of bone for the correction of an angular deformity of the femur. Portal, Ashley Cooper, Warren, of Boston, and others, performed similar operations. All sections of bones prior to 1852 were performed through

an open wound. In that year Langenbeck made a division of the femur for anchylosis of the hip-joint by perforating the bone with a drill through a small wound in the soft parts, and then, introducing a narrow saw, divided the bone. He gave to this operation the name of subcutaneous osteotomy.

In 1868 L. Stromeyer Little made use of a carpenter's chisel to divide the bone in a case of osseous anchylosis of the knee-joint, working through a small wound half an inch in length. In the following year Mr. William Adams performed the operation of subcutaneous section of the neck of the thigh-bone, known as Adams's operation. In 1875 Volkmann[1] operated antiseptically on two cases of anchylosis of the knee-joint, and in April of the same year Macewen performed a similar operation. Ogston, May 17, 1876, divided the internal condyle of the femur with a saw in a case of genu valgum, and Reeves[2] March 17, 1878, made a section of the internal condyle in Ogston's line with an osteotome. And on February 2, 1878, Macewen first performed the operation above the condyle.

Prior to 1875 all osteotomies were performed through an open wound, and were followed by suppuration more or less profuse. In the earlier operations no attempt was made to obtain primary union of the soft parts. Barton states that it was not desired.

Langenbeck's operation does not seem to have been a great improvement upon those performed through an open wound, as deep-seated suppuration

[1] "Edinb. Med. Jour.," March, 1875, p. 794.

[2] "Brit. Med. Jour.," September, 21, 1878, p. 431.

is admitted to have frequently followed, and, as the only object in his method was to prevent such an occurrence, it failed in its object. Moreover, deep suppuration, with a small outlet for the discharge, is more productive of injury than suppuration in an open wound. It was, however, an advance toward a better method of operation—namely, the subcutaneous way in which osteotomy is now performed, and, as such, merits a place in the history of osteotomy. There was also at this time another revolution taking place in surgical practice, which has contributed more to its advance within the last ten years than any one circumstance, and that was the method of treatment of wounds advocated by Mr. Lister.

It was only on account of the safety which this method of wound management seemed to afford that surgeons felt justified in operating upon tissues, with which their predecessors considered it too hazardous to interfere. Although much of the technique of strict Listerism has been abandoned, yet its fundamental principles have stood the test of time—namely, that on perfect cleanliness, thorough drainage, and absolute rest, depend the best results in every operation. That osteotomy has obtained its place as a safe and justifiable procedure is due to the influence of Listerism.

The instruments requisite for an osteotomy are few. It may be performed with a saw, chisel, or osteotome. Mr. Adams's saw, which may be taken as a type of such instruments, he describes as follows: It is three eighths of an inch wide, with a cutting edge an inch and a half in length, at the end of a slender shank three inches long. He at first had a

straight handle, but later substituted a curved one, as being easier to grasp. The saw has a round, blunt end, in order not to injure the tissues behind the bone. (Fig. 1.)

Dr. George F. Shrady, of this city, has modified

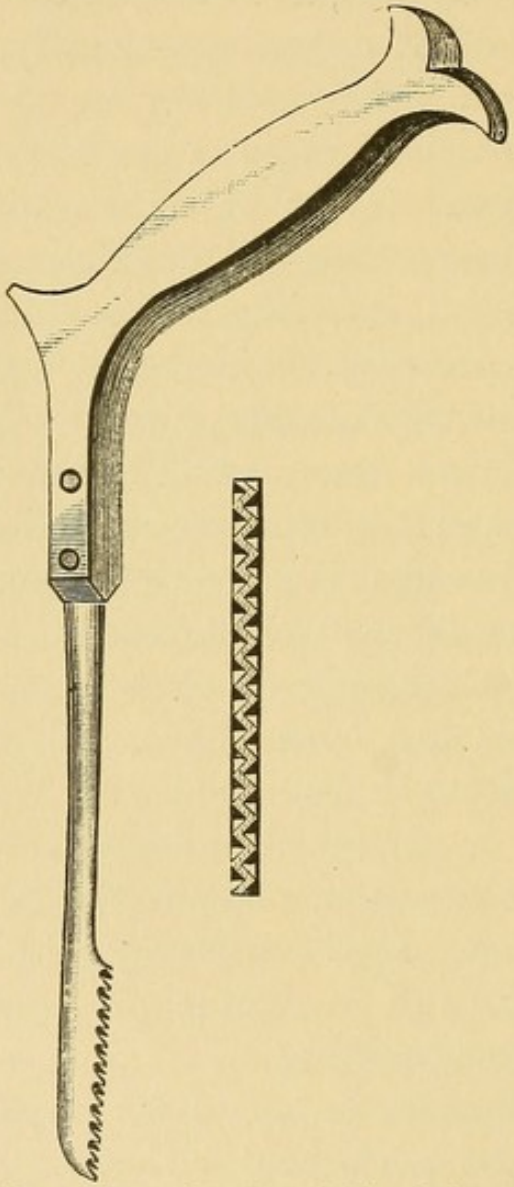


Fig. 1.—Adams's Saw reduced one half, and the cutting edge.

Adams's saw by making it more probe-pointed, and has an arrangement by means of a trochar and canula, so that in introducing the saw all danger of any injury to the vessels and soft parts is obviated.

The instrument consists of first a trochar and canula—the former is of the same size and shape as the saw. The canula has a fenestra corresponding in position to the teeth upon the saw. The method of using it is as follows: The trochar and canula are thrust down by the side of the bone to be divided—the instrument being held in such a position that the fenestrated portion of the canula shall rest upon the bone at the point of desired section; the trochar is then withdrawn and is replaced by the saw; the former is then removed, leaving the saw in position. After the bone has been sufficiently divided the canula is passed down over the saw and both are removed.

It is claimed that with this instrument the danger of injuring the soft parts is reduced to a minimum. I have never used it, but those who have speak well of it. The objections to the use of the saw in osteotomies are: It is harder to work, it takes a much longer time to make the section, there is more disturbance of the surrounding tissues, and, theoretically, the dust from the saw is liable to lead to suppuration, an objection that has not been sustained by practice. Wounds after the use of a saw heal kindly, and the bone-dust does not give any subsequent trouble. The method of using the saw for making section is as follows: An incision is made just large enough to easily admit the instrument down to and by the side of the bone to be divided. The saw is then passed down upon the knife as a guide, and the bone divided through the greater part of its thickness. The saw is then removed, a sponge dampened with carbolized water placed over the wound

to prevent the entrance of air, and the remainder of the bone fractured. The wound is to be treated in the same manner as one after an osteotomy performed with the chisel.

In what experience I have had with the saw in tibial curves it has not seemed to me to be as good an instrument as the osteotome. It is more difficult to work, and it takes a much longer time to complete a section. Thus the time necessary to divide the neck of the femur varies from five to twenty-five minutes, and there is no doubt but that the soft parts are more or less lacerated by the teeth of the instrument. Shrady's saw may do away with this latter objection.

A chain-saw has been used to make the section. Barwell has advocated its use within the past year.

Osteotomy with an Osteotome.—There are two forms of cutting instruments of the chisel order—one having both planes gradually sloping down to a sharp cutting edge, the other made like a carpenter's chisel. To the former Macewen has given the name of osteotome, to distinguish it from the latter, which is properly a chisel. The osteotome is an instrument having its two flat surfaces gradually sloping down to a sharp cutting edge, like a long, slender wedge, resembling a knife-blade, being as thin as it approaches the cutting surface as is safe.

The accompanying cuts (Figs. 2 and 3) represent two views of an osteotome. They are reduced one half actual size. Fig. 2 shows the gradual slope of the flat surfaces, while Fig. 3 represents the latter. Fig. 4 is a smaller osteotome useful for division of the fibula and similar bones.

It should have a temper between that of a cold chisel and a carpenter's cutting tool, so that the edge will not be turned by the hardness of the bone, or so

Fig. 2.

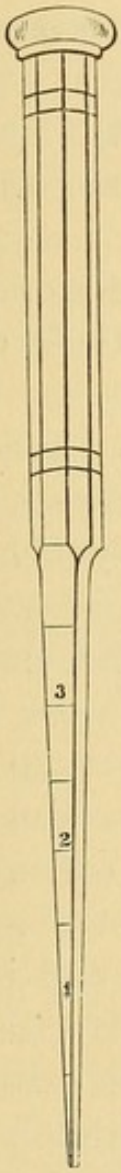


Fig. 3.

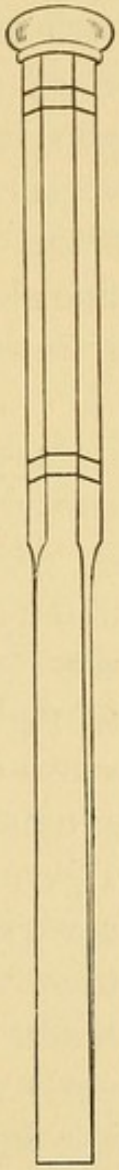


Fig. 4.

brittle as to chip. It is well always to test the instrument on a piece of hard bone, driving it in with a pretty strong blow with a mallet. If the edge is neither turned nor nicked, it is of a proper temper. The cutting edge should be very sharp. It should

be marked on the flat surface every half-inch from the edge, in order that the distance that the instrument has penetrated the bone may be known. A large handle is also of advantage, as it can be grasped more easily. The best width is half an inch. It is well to be provided with three osteotomes of the same width, but of different thickness, in order that, if the largest gets wedged, it may be withdrawn and replaced by the next smaller, to be again replaced by the third if it be found necessary. I also have an osteotome of the same shape, but only one quarter of an inch wide, for section of the fibula or any small bone.

Most of the osteotomes found in instrument-stores are not made properly. They have a bulge just above the cutting edge, like a post-mortem chisel. In some trials made upon the cadaver with such an instrument it was found that the bone was invariably splintered at right angles to the line of desired section, the fracture extending several inches above or below the instrument. This was due to the thickness of the chisel just above its cutting edge acting too much like a wedge. The force required to drive such an instrument into the bone is much greater than with one made with straighter lines.

An instrument properly made can be driven into the bone without turning from its direction.

The mallet should be made heavier than those sold in necrosis cases. In fact, a good-sized carpenter's mallet is the best. A sand pillow, about six by eight inches square and three quarters filled with sand, and covered over with rubber cloth, complete the special outfit.

The chisel for performing a cuneiform osteotomy is shaped much like a carpenter's; half an inch is sufficient for its width. It should taper down more than the common necrosis chisel, and the beveled portion should not be too large. It should have a temper similar to the osteotome.

Osteotomy is either linear or cuneiform. The former is performed through a small wound, just large enough to easily admit the osteotome. The latter must be done through an open wound, and is therefore not subcutaneous.

The limb in either case, if possible, should be rendered bloodless by the use of an Esmarch bandage or any other method, as, especially in cuneiform sections, it renders the operation much easier and does away with the constant use of the sponge.

In regard to the use of Listerism, I am clearly of the opinion that it affords no additional safety, and I have long since abandoned its use. The method of management of the wound will be given in detail farther on.

Simple Osteotomy. — The patient having been placed thoroughly under the influence of an anæsthetic, the limb rendered bloodless if that is possible, and the point of section decided upon, an incision is made with a sharp scalpel immediately down to the bone. Unless there are special reasons for so doing, the bone should not be reached by dissecting down to it, but a quick, clean cut should be made. The line of the incision should be parallel with the line of the fiber of the muscles through which the wound passes. As a rule, this is parallel with the long axis of the limb. The place of in-

cision should be so planned as to avoid any artery or vein. The length of the wound should be only sufficient to easily admit the osteotome. This instrument is then passed down upon the knife as a guide, and, when the former is well down upon the bone, the latter is withdrawn, and the osteotome is rotated so as to be at right angles with the long axis of the bone, and then driven in with pretty firm blows with the mallet. After each blow the instrument is moved in a direction at *right angles* to the long axis of the bone—that is, in the line of the axis of the instrument—in order to keep it from becoming wedged and to change the direction of the cut in the bone. It is also well, in bones of any width, to first divide the bone throughout its superficial surface, and then gradually to work from without inward through its width. Under *no circumstance* should the osteotome be used as a lever, as it will result in breaking the instrument. In some cases the bone may be divided in a fan-shaped manner by working in different directions from the point of first entrance. Divisions should be commenced with the largest osteotome, if the bone is of any size, as the femur or tibia, because after a time the instrument becomes wedged and is difficult to work. It can then be withdrawn and replaced by the next smaller, this to be again replaced by the third if necessary. Another reason is, that, by using the largest first, the cut is made more V-shaped. When the osteotome has penetrated the hard, compact, bony tissue in the external portion, it will be felt to work more rapidly. When the external portion on the opposite side of the bone is reached, it will

be detected by the resistance in cutting. Then, as Macewen remarks, the osteotome acts as a probe as well as cutting instrument.

During section the wound may be kept damp with carbolized water, but I do not think it essential, nor do I place my instruments in any antiseptic solution before using. When the bone has been nearly divided, the osteotome is removed and the section completed by fracturing the remaining portion, a sponge wet with carbolized water being first placed over the wound and held firmly in place to prevent the entrance of air. The bone should have been sufficiently severed to make the fracture easy without the use of much force. If, however, it can not be broken without the use of too much force, the osteotome is re-entered and further section made. After fracture, the sponge is firmly secured over the wound with a few turns of a bandage, and then the Esmarch bandage removed. The limb is then left while the same operation is performed upon the other side. In case only one limb is to be operated upon, it is well to let the parts remain at rest for a few moments until the circulation in the limb has been re-established. The hæmorrhage after an osteotomy is slight. I have never seen enough to cause any anxiety, although in a few cases there may be quite a free venous hæmorrhage if the sponge has been removed too soon. There is, moreover, more blood oozing from the wound when the section has been made near the epiphysis of the tibia or when the bone is superficial. In deep osteotomies the blood is effused among the muscles, and does not come out of the wound unless pressed

out. I have once divided an artery of some size, to which reference will be made in another place.

Management of the Wound.—On removing the sponge from over the wound, it will be found that the hæmorrhage has almost ceased, but that blood can be forced up from its deeper portions, or will continue to ooze if the bone be superficial. Macewen has advised that any piece of adipose or cellular tissue that may protrude from between the lips of the wound should be removed with a pair of curved scissors, as it will prove a source of irritation and prevent the closure of the wound by a blood-clot. Experience has proved that this is an important point, and, from the neglect of this, failure to obtain rapid closure of the wound is almost always due. Macewen dresses the wound on strict Listerian principles. I do not think that there is any gain thereby. The method that has gained excellent results is as follows: In deep wounds, after removing any piece of tissue from between the lips of the wound, it may be washed out with some carbolized water of the strength of 1 to 40, and, after the parts are well dried, a strip of adhesive plaster, about half the width of the length of the wound, and long enough to pass one quarter of the way around the limb, is applied, passing over the center of the wound, care being taken to bring the edges of the incision into perfect coaptation. The object in only partially covering the incision is that, if there is any undue accumulation of blood, it can find vent through the portions of the wound not covered by the plaster, and thus prevent tension of the parts. The limb about the point of operation is now dusted over with iodoform diluted

with subnitrate of bismuth, and over this is placed a small compress of cheese-cloth, two or three inches square and four or five layers thick. Or a compress of Lister's gauze may be used. If it is possible, a flannel bandage is applied from the extremity to some distance above the point of section, and over this a plaster-of-Paris bandage (we are considering osteotomies below the middle of the thigh). Before the plaster sets, the deformity should be corrected and held in the proper position until it has well hardened. I think it is well always to overcorrect a little, for, as the bandage becomes loose, there is a tendency to lose a little of the correction. It will be found that, by the addition of some sulphate of potash to the water in which the plaster-of-Paris bandages are soaked, they will harden much more rapidly.

The bandage on the following day will be found more or less stained with blood from the oozing that has taken place, but it is of no consequence, and needs no attention. On the third day a fenestra should be cut over the seat of the wound, the compress removed, and the wound examined. An easy way to remove a small window is to make two cuts with a saw, at right angles to the long axis of the bone and about two inches apart, through the plaster, and then to unite their extremities by cuts with a strong knife. The square piece can then be lifted out, the flannel bandage cut, and through this opening the compress removed and the wound examined. The adhesive plaster need not be removed. If there is any oozing from the cut, a fresh piece of compress should be applied, and the wound examined every day. If it is

dry, a little lint may be placed over it, and no further dressing is required.

The result from this way of managing wounds has been eminently successful. In all but exceptional cases the incision has been found united on the third day, being represented by a mere line. Macewen's method aims at union by means of an organized clot. Of this method he says:[1] "During the first twenty-four hours the dressings ought to be looked at, in order to detect any appearance of blood-stains. If a stain of blood shows itself, the dressings must be removed. If there is no blood-stain during the first forty-eight hours, it is unlikely that any will afterward appear. . . . The dressings are put on (strict Lister) in the operating-room, and not touched, unless blood appears, for a fortnight."

Again, on page 175, in speaking of the organization of a blood-clot, he says: "The ordinary course which a wound healing by blood-clot takes may be described as follows: The blood is effused between the lips of the wound, and forms a clot. During the first few days a layer of translucent, yellowish material is often effused from the surface of the clot. This, however, is not constant. During the first week the blood-clot remains soft and moist; then it becomes opaque round the margins, and by and by dries, the opacity and dryness gradually extending centripetally." Closing of a wound by a blood-clot takes ten or twelve days; by primary union, two or three days.

With care to remove everything that may protrude from between the lips of the wound, primary

[1] "Osteotomy," *loc. cit.*

union should be obtained in all cases. The simplicity with which the plan advocated in these pages can be carried out is in contrast to that of Macewen. Since adopting this method, I have performed over sixty linear osteotomies. In all but three cases the wound was united on the third day. Failure to obtain primary union was in two cases due to the fact that the wound was not properly cared for. In the third no reason can be assigned.

It is evident that the earlier the wound closes the less is the liability of any accident, and the closer will the reparative process in the bone follow the course of a simple fracture. I believe that the success of an osteotomy depends more upon the management of the small incision than upon any detail in the section of the bone, and that the neglect to remove any tissue that protrudes between the lips of the incision is the cause above all others of suppuration.

The temperature after an osteotomy seldom rises above 100° F., and in the majority of cases does not get above normal. In a few patients I have seen a temperature of 102° or 103° F. without any assignable cause, the wound pursuing a perfectly normal course. As a rule, however, a registration of the mercury above 100° after the third day demands a careful inspection of the wound, as it may denote suppuration. The temperature in children often rises rapidly, and has as sudden fall without any serious import. A temperature of 103° the day after an osteotomy in an excitable child has been met with, yet the wound, on inspection, appeared perfectly normal, and primary union was obtained. Again,

I have seen quite a large abscess in the soft parts, of which the thermometer gave not the slightest indication. So the thermometer is not an infallible guide as to the presence of pus.

The pain after an osteotomy is generally slight. I have seen a child, two hours after an osteotomy of both tibia, sitting up in bed and playing with her toys as though nothing had been done. But, as a rule, a small dose of some anodyne is required the first night.

The first dressing (plaster splint) can usually be left on until firm union has taken place and the patient is well enough to be up and about.

Cuneiform Osteotomy.—In anterior curvatures of the tibia, and in angular deformities of the long bones, a wedge of bone has often to be removed. For this purpose a *chisel*, and not an *osteotome*, is used, and the operation is through an open wound.

An Esmarch bandage having been applied, an incision is made parallel to the long axis of the limb, directly down to the bone at the point of greatest curvature, long enough to give plenty of room, which will be found, in the deepest portion of the wound, to be a little longer than the width of the wedge to be removed. If the bone is covered with much muscular tissue, the incision in the skin will have to be somewhat longer. The periosteum is divided in the same line as the incision in the soft parts, and is of the same length. Another short incision at right angles to the first at about its middle is often an advantage. The periosteum is then separated from the bone well down on either side. The exact size of the wedge to be removed should be accurately ascertained before beginning the operation.

A ready way is to take a narrow piece of lead and mold it to the curvature of the bone. This can be traced upon a piece of paper or card-board, and a line drawn parallel to it at a distance equal to the thickness of the bone. By cutting this out you have a pattern of the outline of the bone. Now cut this in two at the point of greatest curvature, and, by placing one piece over the other until the line of the upper border is straight, the amount that one overlaps the other will represent the size of the wedge to be removed.

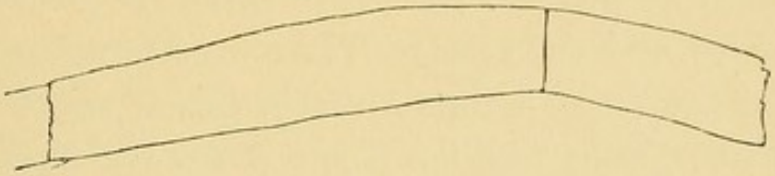


FIG. 5.

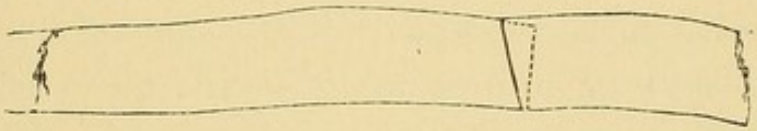


FIG. 6.

Figs. 5 and 6 are reduced from the pattern of a case of anterior curvature of the tibia. Fig. 5 shows the amount of deformity, and the dotted lines in Fig. 6 the size of the wedge of bone to be removed, in order to correct the deformity.

In the beginning a much smaller wedge should be removed than is required, by cutting with the flat side of the chisel toward the part of the bone to be left. This can be increased by chips or shavings removed alternately from either side, and gradually increasing in depth. By keeping the chisel inside of the periosteum, there will be no danger of injuring

the soft parts on either side of the bone. The apex of the wedge should extend well into the compact tissue on the opposite side of the bone. When this point has been reached and the whole width of the bone included in the wedge, the section can be completed by driving an *osteotome* directly backward from the apex of the cuneiform section. If the V-shaped piece has been accurately calculated, the two opposite surfaces will come into apposition, and the deformity just corrected. During the operation, care should be taken to remove all the shavings of bone. A sponge wet with carbolized water is placed over the wound and the Esmarch bandage removed. The hæmorrhage from a cuneiform is much greater than that from a linear osteotomy. After the circulation has become re-established in the limb the sponge is removed, and any vessel that may cause trouble secured with carbolized gut. The edges of the periosteum are to be approximated with antiseptic ligatures. If the bone is subcutaneous, and if it is possible, a counter-opening should be made opposite the apex of the wedge, and carbolized horse-hair passed from this through the operation wound. The lips of the wound should then be brought into perfect coaptation with carbolized gut, the horse-hair being brought out at one corner. Over the line of incision iodoform is dusted, and then a small compress applied sufficient to cover the wound, and over this again a flannel bandage and plaster-of-Paris splint, if in a position where such a dressing is applicable. On the second day a fenestra is to be cut, the compress removed, and the horse-hair is taken out piece by piece. This is easily done without giving the

patient any pain. A fresh compress is applied, and over this a bandage to keep it in place.

The reason why a counter-opening is advocated is because in a certain class of cases, where the bone is superficial, on account of the increased amount of hæmorrhage there is liable to be too much tension of the skin, thus preventing primary union. Before I adopted this plan I invariably had suppuration, but since its adoption have secured primary union in every case.

In correcting after a cuneiform osteotomy great care should be taken that no portion of tissue gets between the ends of the bone. Should such an accident happen, suppuration will be sure to follow. I think that many cases of suppuration after this operation are due to this accident.

An argument has been frequently used against osteotomies, that in performing them compound fractures are produced, and as compound fractures are exceedingly dangerous, therefore osteotomies are exceedingly dangerous operations. In only one respect can an osteotomy be classed with a compound fracture, and that is that in both there is a communication between the ends of the bone and the air; but the bone is reached in the former by a clean-cut wound without any disturbance of the soft parts; in the latter the wound is a contused and lacerated one, caused either by the ends of the fractured bone, or by the violence causing the injury. The danger from a compound fracture is not the simple fact that there is a communication with the bone, but that the soft parts are torn and lacerated, and herein arises the danger. Osteotomy should be classed as simple fracture.

CHAPTER III.

OSTEOTOMY FOR DEFORMITIES AT THE HIP JOINT.

Deformities at the hip joint which may be relieved by an osteotomy may be considered under four heads, namely:

1. After hip-joint disease.
2. After rheumatism.
3. After unreduced dislocation.
4. After fractures united at an angle.

The great majority of deformities of this joint follow coxalgia. There are but few persons who have had suppurative disease of this articulation who recover with motion, and many in whom there have been no signs of abscess, yet the joint remains stiff, with an amount of flexion and adduction which interferes much with locomotion. Or there may be some movement, yet, on account of the contraction of the psoas and iliacus, and the adductors, the limb is flexed and adducted on the pelvis at an angle too great for easy locomotion. The foot can not be planted firmly on the ground even with the greatest latitude of motion at the lower lumbar vertebræ, the gait being awkward and labored. It becomes a question whether by an operation any improvement can be obtained.

An anchylosed hip joint, in which the limb is held in a perfectly straight line with the long axis of the body, is a useful one for walking or standing, but is more of a deformity in any other position of the body than one fixed at a right angle to the pelvis. In the former case the person can not sit down with any degree of comfort, or put on his shoes, whereas in the latter, by the aid of proper orthopedic appliances, not only is the sitting posture comfortable, but locomotion can be performed with considerable facility. It therefore becomes an interesting question at what angle an anchylosed hip should be placed so as to be a compromise, as it were, between the two positions, and give the patient the greatest amount of use; that is, easy walking and comfort in the sitting posture. I think that an angle of 125° with the transverse axis of the pelvis when in an erect position gives this. It permits of comfortable locomotion, ease in sitting, and ability to put on his shoes. This, then, taken as a standard, enables us to discuss the question of correcting any marked deviation on either side of this line. The angle of deviation is obtained by standing the patient erect and bringing up the thigh until the lordosis is obliterated, or, in other words, until the pelvis assumes its normal position.

The deformity after hip-joint disease is due, first, to contraction of the psoas and iliacus muscles, causing flexion and rotation of the limb; second, to the action of the adductors, drawing the thigh toward the median line. This is accompanied or followed by tilting of the pelvis upward on the diseased side in order to bring the limb more in a line with the

long axis of the body, and thus prevent it from crossing over the sound one. It is a compensatory, not pathological, position. In the early stage of this affection the apparent shortening is due to this tilting of the pelvis. Later, in those cases in which changes take place in the head and acetabulum, there is actual shortening of the limb.

The absorption more or less of the head of the femur, and the higher plane occupied by the trochanter, due partly to the above-mentioned change and partly to elongation of the acetabulum in its upper or posterior diameter, increases in no small degree the deformity and the amount of shortening of the limb.

The difficulty in walking is not due so much to the shortening and flexion as to the adduction of the limb, whether the anchylosis be bony or fibrous. The characteristic awkward gait of a patient who has recovered from a coxalgia with anchylosis is due to the tilting upward of the pelvis on the diseased side. In time other muscles become shortened, and add another element to the problem of correction.

The muscles chiefly at fault are the psoas and iliacus, and the adductors; and, even when the deformity is corrected by any operation above the insertion of the former, the question still remains, How can we elongate them? From their origin and insertion being movable, it is impossible to apply any force in order to lengthen them. When extension is applied to the thigh the lumbar vertebræ arch forward (lordosis), and when the lordosis is obliterated the thigh is flexed more or less, being carried forward by the pelvis.

In those cases in which anchylosis does not take place there may be motion in the direction of further flexion, but extension beyond a certain point is impossible; and, although the thigh can be brought down so that the foot can be planted flat on the ground, it is not from further extension, but is accomplished by bending inward of the lumber spine, due to the same shortening of the muscles inserted into the trochanter minor. In this class of cases walking is almost as difficult as in those where the joint is fixed.

In cases where suppuration has been extensive the soft parts about the region of the hip joint are often infiltrated with cicatricial tissue which binds the skin to the bone.

In anchylosis following rheumatic inflammation the condition of the parts is entirely different; the head and neck are intact, the bone is not infiltrated with inflammatory products of low vitality. It may be increased in hardness, but the parts retain their normal relations, the neck is not shortened, the anchylosis is usually bony, the soft parts are normal, and the psoas and iliacus are not as much of an element in causing the deformity. It is due more to position, while in hip-joint disease it is the active contraction of the muscles that causes the deformity. In this disease the limb may be fixed in a straight line with the body, a condition very seldom, if ever, met with after coxalgia.

In rheumatoid arthritis the joint may be surrounded by irregular bony growth, while the bone itself is very compact and hard, like ivory.

Deformities due to unreduced dislocations are not

of frequent occurrence. The dislocation may be traumatic, or pathological.

The latter may occur during the course of hip-joint disease, but I do not think that they are as common as some writers would lead us to suppose. It may occur during the course of some debilitating disease, as typhoid fever.[1] I have seen one taking place upon the dorsum of the ilium during an at tack of acute polyarticular rheumatism, complicated with serious heart trouble. Burns[2] reports a similar case. In cases of dislocation in hip-joint disease the head is often found much altered.

Malpositions of the femur after fracture are sometimes met with, and should be included in this class.

In all of these cases (fracture of the femur excluded, unless they occur very high up) one of the chief obstacles to the correction of the deformity and causing the difficulty in walking is the contraction of the adductors. Flexion alone is not the chief cause of the trouble. It is the adduction of the limb; and, even if the dislocation is reduced, the muscles carry the limb inward, and must be cut in order to afford relief.

There is a well-grounded opinion among practical surgeons that any attempt to correct deformities at the hip joint after suppurative coxalgia, or to regain motion in this articulation, should not be entertained. My own experience has been anything but encouraging. Two cases in which I made the attempt resulted in rekindling a disease in the joints that had shown no symptom for several years, and which, in one, ended in the death of the patient.

[1] Rawdon, "Liverpool Med.-Chir. Jour.," 1882, p. 22. [2] "Centralbl.," 1879, p. 691.

Morton, of Philadelphia, has had a similar unfortunate experience.

The records of many hospital surgeons show similar results. It is true that in a few cases the operation of forcibly straightening has been followed by success. Gay reported such a case at the meeting of the American Medical Association, 1882, in which the neck was fractured and an improved position obtained. Mr. Broadhurst[1] also advocates forcible straightening, and claims remarkable success. But the cases are so carelessly reported that it is impossible to form any opinion of the results. I am decidedly of the opinion that under *no circumstances* should a hip joint that has been the seat of suppurative coxalgia be forcibly straightened. It is a dangerous operation, and is unwarrantable.

The position of the trochanter on the diseased side may be taken as an index of the amount of alteration in the head and neck of the femur. If it is higher than on the sound side, the position of the foot being normal, the change must be due, in the vast majority of cases, to absorption of the head and neck; and the more the upper border of the trochanter major is above Nélaton's line, the more profound must be the alteration in the upper part of the femur. Shortening of the limb, that is, the measurement from the anterior-superior spine of the ilium to the internal malleolus is not as reliable a guide as to the condition of the neck as the position of the trochanter, because the whole limb may be atrophied from disease without any marked change in the neck.

[1] "On Anchylosis," London, 1881.

History.—In 1826, Rhea Barton[1] devised and carried out the following operation for anchylosis of the hip joint at a right angle subsequent to inflammation of that articulation: The patient was a sailor twenty-one years of age. The limb was flexed at a right angle, rotated inward, and adducted. A straight incision was made parallel to the long axis of the limb at the upper portion of the thigh, and a short transverse one at the point of intended section. The bone was divided with a narrow saw just above the trochanter minor. No vessels were ligated. Primary union was not desired. The operation was completed in seven minutes. Passive motion was commenced on the twentieth day, and repeated at intervals of several days. At the time of discharge, two months after the operation, the patient was able to execute "every movement which the limb originally possessed." He had a movable joint for six years, when he became dissipated, the new joint gradually became stiff, and at post-mortem examination the artificial joint was found anchylosed.[2]

Rodger,[3] in 1830, removed a wedge-shaped piece of bone above the trochanter minor from a man forty-seven years of age, for anchylosis of the hip joint, at a right angle, with marked adduction. Clèmot,[4] in 1834, removed a wedge-shaped piece from the femur of a child four years of age for a deformity following hip-joint disease.

[1] "North Am. Med. and Surg. Jour.," 1827, vol. iii, p. 279.
[2] "Am. Jour. Med. Sci.," 1837, vol. xxi, p. 333.
[3] "N. Y. Jour. Med. and Surg.," 1840, p. 240.
[4] "Gaz. Med. de Paris," 1836, p. 347.

Maisonneuve[1] made a section between the trochanters.

Mayer first proposed an osteotomy for old dislocation, and Broadhurst, in 1862, divided the neck of the femur for anchylosis with deformity following hip-joint disease.[2] All of these operations were made through an open wound, and the section made with a saw.

In 1862 Dr. Lewis A. Sayre[3] made a section of the femur just above the trochanter minor and removed a "semicircular piece of bone with its concavity downward" and rounded off the upper portion of the lower fragment so as to be received into this cup-shaped depression, and thus aid in establishing an artificial joint. The first patient operated upon in this manner is reported "cured" with a movable joint at the point of operation. He repeated the same operation later upon another patient, but she died of tuberculosis before a sufficient time had elapsed to establish good and useful motion. In both of these cases there was necrosis of a portion of the bone: in the first, two pieces that "seem to be exfoliated from the lower fragment"; in the second, "two pieces about the size of a pin's head." In the last case, at post-mortem examination the structures of a new joint are reported to have been found. (Fig. 7 shows the line of Sayre's section.)

Walter[4] repeated Sayre's operation for anchylosis of both hip joints. After considerable suppuration,

[1] "Gaz. Med. de Paris," 1847, p. 935.

[2] "Lancet," 1862, vol. i, p. 326.

[3] "N. Y. Med. Jour.," January, 1869, p. 337.

[4] "Arch. Clin. Surg.," August, 1876, p. 60.

the patient is reported as having only limited motion at the new articulation, with a history of a tendency to become stiff.

In 1863 Weinlechner performed a section through the neck with a chisel. Langenbeck, in 1852, corrected deformities in the hip joint by dividing the bone with a narrow saw, passed into the bone through a small perforation made with a drill. Suppuration followed in all the cases operated on. Mr. Adams, in 1869, first divided the neck of the femur through a small wound, and gave to the operation the name of subcutaneous osteotomy. Since that date sections of the femur for deformity have been performed by surgeons both on the continent and in this country.

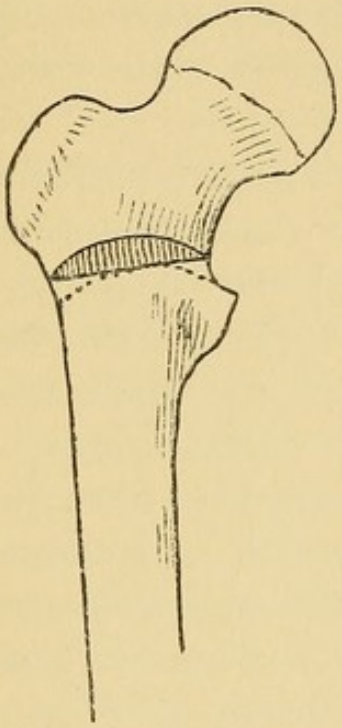


Fig. 7.—Sayre's line of section.

Volkmann[1] removed a wedge-shaped piece of bone from below the trochanter major in order to correct the adduction in bony anchylosis (Fig. 8). Later[2] he substituted an excision of the joint with a chisel and gouge, a linear osteotomy being first performed, and then the head and neck removed in small pieces. He reports six patients operated upon with good results in regard to the re-establishment at the new articulation.

The three points at which section has been made

[1] "Centralbl. für Chirurg.," 1874. No. 1, p. 1.

[2] "Centralbl. für Chirurg., 1880, No. 5.

on the femur are through the neck, between the trochanters, and below the trochanter minor.

Maisonneuve, in 1847, divided the neck of the femur through an open wound,[1] and Weinlechner in 1863. But to Mr. Adams is due the credit of devising an operation through a very small wound and reducing the risks of suppuration to a minimum. The instruments used were a long tenotomy-knife and a very small saw (Fig. 1), three eighths of an inch wide, with a cutting edge one inch and a half in length, at the end of a slender shank three inches long. The details of the operation are as follows: The tenotomy-knife is entered a little above the top of the great trochanter and carried straight down to the neck of the thigh-bone. The muscles are divided and the capsular ligament freely opened. Withdrawing the knife, the small saw is carried along the track made straight down to the bone, which is then divided from before backward, and at right angles to the long axis of the neck.

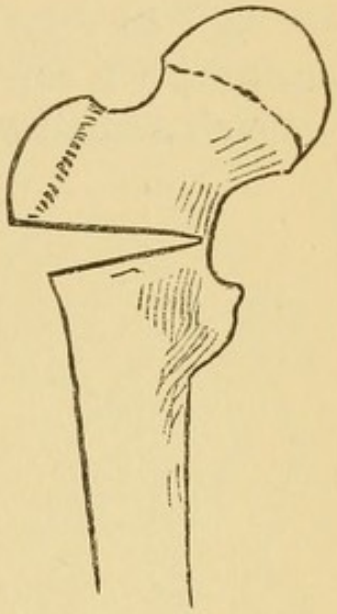


Fig. 8.—Volkmann's line of section.

After the division is completed (Fig. 9), those muscles that prevent the limb being brought into the desired position are divided and the limb put up in a straight position. He simply covers the wound with a compress held in position by a piece of adhesive plaster.

[1] "Gaz. de Hôp.," 1849, p. 64.

Golding-Bird substituted a chisel for the saw.[1]

Stokes[2] divided the neck with an osteotome in Adams's line.

Operations between the trochanters have been performed by Barton and Maisonneuve and Sayre through an open wound, division of the bone being made with a saw. Later, sections have been made through a small wound with the osteotome. But few cases have been reported. The operation is performed like any simple osteotomy. Cuneiform section between the trochanters has been more frequently performed. They seem to be adapted to those cases of marked adduction.

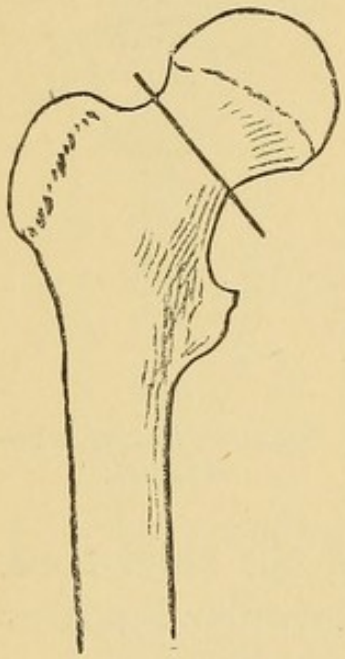


Fig. 9.—Adams's line of section.

Mr. Barwell[3] divided the femur just above the trochanter minor with a chain-saw, and a strict antiseptic method, arguing that a section below the trochanter minor would produce too much shortening, equal in amount to the distance from the head to the point below the trochanter—from two to three inches. The wound healed by first intention; a firm union was established in thirty-three days.

Mr. Gant[4] made a section with an osteotome of

[1] "Guy's Hospital Report," 1877, p. 278.
[2] "Brit. Med. Jour.," April 8, 1882, p. 505.
[3] "Brit. Med. Jour.," May 29, 1880, p. 812.
[4] "Lancet," December, 1872, p. 881.

the shaft of the femur below the trochanter minor for deformity at the hip joint (Fig. 10). He advocated it for anatomical reasons: that the resistance of the psoas and iliacus was set free, and on the pathological grounds in that the section was made through healthy bone, or rather at a greater distance from the point of disease after coxalgia, and thus the operation was not as liable to rekindle the joint trouble.

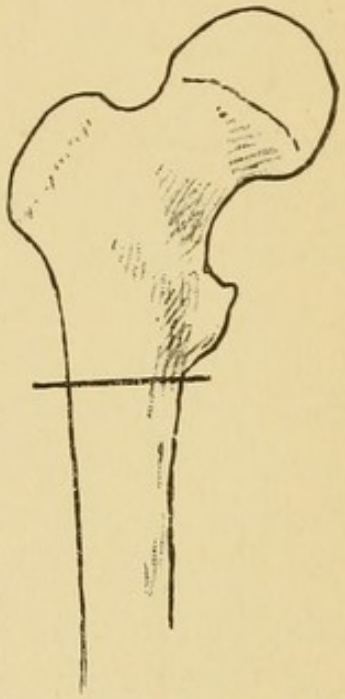


Fig. 10.—Gant's line of section.

Lately, Dr. Stephen Smith[1] performed the following operation for anchylosis of the hip-joint at a right angle: With a Shrady's saw he made two partial sections of the femur just below the trochanter minor—one from its posterior and one from its anterior aspect — half an inch apart, and then fracturing the intervening portion of bone, thus making a half tenon and mortise, the object being to prevent any tendency to displacement of lower fragment so as to endanger non-union. After placing the bone in position, the two fragments would assume the relations exhibited in Fig. 11.

The patient recovered after evacuation of a large abscess, extending from the point of operation nearly down to the knee.

Adams's operation can only be performed when the neck of the bone is present. It is therefore only

[1] "Med. Record," Jnne 2, 1883, p. 589.

applicable to cases of anchylosis following rheumatism, and possibly those cases of recovery from hip joint disease in which there has been but slight destruction of these parts with bony anchylosis. But it is a serious question whether cases of deformity after suppurative coxalgia should *ever be* submitted to the operation. In the vast majority of cases the section would be through bone infiltrated with inflammatory products of low vitality. The incision, to gain access to the neck, would frequently have to be made through tissue that had been riddled with abscesses, and with the skin often bound down to the bone, and even after a section it would be very difficult to bring the limb down. Adams's operation is not applicable to cases where the psoas and the iliacus are greatly shortened, and this occurs more often after hip-joint disease than after anchylosis following any other condition.

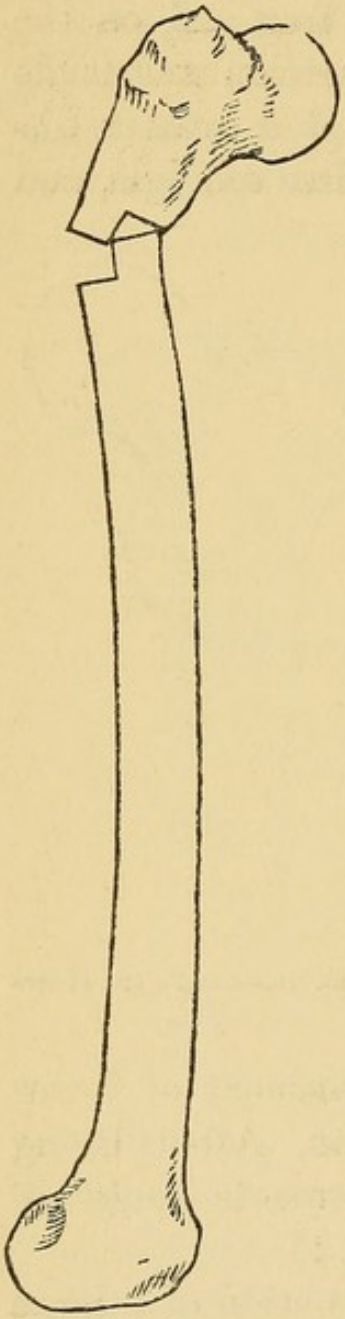


Fig. 11. — Smith's line of section.

Cases of unreduced traumatic dislocation offer a much better chance. In regard to the class of cases that are suited to the operation, Mr. Adams justly states "that those cases are best adapted to this operation in which there is but slight destruction of

the head and neck, and in which there is bony anchylosis, and that cases of anchylosis after rheumatic inflammation are the most favorable; those after suppurative coxalgia the least so."

In regard to operations between the trochanters the section is made farther away from the seat of disease in cases of deformity after suppurative coxalgia, and it also permits of a wedge-shaped piece of bone to be removed, if so desired, in cases of marked adduction. Yet, as the point of division is above the insertion of the psoas and iliacus, there is a doubt whether the deformity is as easily overcome as in section below that point. If the object of an operation is to obtain useful motion in addition to the correction of the deformity, there is no question but that the nearer the division is made to the true axis of motion the better. But useful motion after an osteotomy, be it linear, cuneiform, or elliptic, is rarely obtained, no matter where the section is made. Motion has been obtained in some cases, but they are exceptional. I do not think that an inter-trochanteric operation is the best for deformity after joint disease. It is too near the point of old disease, and it *does not* free the muscles inserted into the trochanter minor. It is, however, a good operation when the bone is healthy; the operation below the trochanter minor is the one to perform after hip-joint disease. Mr. Gant[1] thus very concisely states the question when section should be performed below and when above the trochanter minor.

1. "When in consequence of continued disease of the hip joint the head of the femur has disappeared,

[1] "Brit. Med. Jour.," October 18, 1879, p. 606.

leaving only a stunted nodule of bone, representing the neck above the trochanter, in such a case the operation of section in the femoral neck can not be performed, there being no neck to divide. This advanced degree of destruction may be ascertained by careful measurement of the femur compared with the other. Even when supra-trochanteric section is practicable the state of the neck may render this operation abortive. The seat of the operation will be in an almost carious portion of bone which is unfit to yield a fibrous union, or possibly atrophy or necrosis of the upper portion of the neck may ensue by cutting off vascular supply from bone already devitalized.

2. "Another class of cases inappropriate for Adams's operation is when, the anchylosis having resulted from rheumatic arthritis, there is an exuberant deposit of new bone, forming hard nodules or spiculæ around the femoral neck, itself entire. The thickening and induration existing will resist any justifiable attempts to divide the bone in this situation."

In cases, however, of deformity after acute traumatic inflammation of the hip, a high section is justifiable.

STATISTICS.

Sections through the Neck (68 *cases*).—In 17 the deformity was due to rheumatism; in 27 it followed hip-joint disease; in 7 to unreduced dislocations, pathological and traumatic; in 1 to osteo-myelitis of the femur; and in 16 no cause was assigned. In 3 of the patients both hips were anchylosed. The bone was divided with a saw in 40 cases, in 15 with an osteo-

tome, and in 12 the instrument is not mentioned. In 13 cases, suppuration followed the operation. In 8—Golding-Bird,[1] Croft,[2] Servais,[3] Billroth,[4] Willetts,[5] Adams,[6] Holmes,[7] a case mentioned by Wharton[8] and Shaffer[9]—it was excessive. In 3—Maunder[10] 2 cases, Adams[11]—it was slight, and in one Hutchinson[12] an abscess formed at the seat of section, but not connected with the bone four months after the operation. In three cases there was more or less necrosis following the operation (Golding-Bird, Servais, and Billroth).

Six deaths have been reported: One by Croft, from pyæmia, due to extensive suppuration and caries of the head of the femur. The deformity was due to hip-joint disease. One by Billroth, from pyæmia, four months after the operation, the deformity following hip-joint disease. One by Willetts, where extensive suppuration and caries of the head followed the section, and for which amputation at the hip joint was performed, the patient dying within twenty-four hours. One by Adams, eight months later, from tuberculosis. One by Holmes, from exhaustion due to long and extensive suppuration. And one by Shaffer, from relapse of the joint disease, followed by extensive suppuration and death, two years and a half after the operation. A percentage of 8·82 +. It should be stated, however, in justice to the last operator,

[1] "Guy's Hosp. Rep.," N. S., vol. xxii, p. 275.
[2] Adams, "Trans. Med. Chir. Soc.," vol. lx, p. 1.
[3] "Rev. de Chir.," Dec., 1881, p. 1043. [4] Langenbeck's "Archiv.," vol. xviii.
[5] Adams's Table, *loc. cit.* [6] *Loc. cit.* [7] "Lancet," Oct. 14, 1876, p. 535.
[8] "Am. Jour. Med. Sci.," April, 1883, p. 101.
[9] "Annals Anat. and Surg.," Dec., 1883, p. 243.
[10] "Lancet," March 25, 1876, p. 476. [11] Adams's Table, *loc. cit.*
[12] "Brit. Med Jour.," March 4, 1882, p. 298.

that, had he been permitted to excise the joint after suppuration had taken place, the fatal result might not have followed.

In those patients in whom recovery took place bony union was reported in fifteen cases. Fifteen are reported to have some motion at the point of section at the time of dismissal. Nineteen were discharged cured, one improved, one with limb flexed at angle of 150°, and in four the deformity after a time returned.

In regard to motion, in the majority of the cases it was only slight. In two patients of Lund's, in whom there had existed anchylosis of both hip joints, free motion is reported in one, fourteen and sixteen months, the other six and nine months after the operation, the section of the two limbs having been performed at different dates. In Sands's case fair motion was obtained, and, I am informed, lasted for several years, but the false joint gradually became stiff and firmly anchylosed. In the remaining cases the motion was in time lost and the limbs became stiff.

The deformity in sixty-one cases consisted of flexion and adduction, and in seven limbs the anchylosis was in a straight position.

Sections below the Neck (*Linear*), 64 *cases.*—The deformity was due to hip-joint disease in 39 cases; to abscess of the hip joint after confinement, 1; rheumatism, 2; to injury, 1; in 21 cases the cause was not mentioned.

The section was made between the trochanters in 10; below, in 52; in 2 cases the point of operation is not mentioned. Only 11 operations were performed under strict antiseptic methods (Lister).

The result was:

Cured with firm anchylosis	52
Cured with motion	2
Result not satisfactory	1
Improved	3
Died	6
Total	64

The cause of death was, one reported by Borchers,[1] due to relapse of the joint disease; one by Billroth,[2] from extensive suppuration nine weeks after the operation; one by Billroth,[3] pyæmia, seventh day; one by Bryant,[4] from pyæmia, thirty-six days after an operation for deformity of both hip joints, due to extensive suppuration from bed-sores; one by Porter,[5] from exhaustion due to suppuration above the point of operation four months later, and one by Margary,[6] from collapse on the day of the operation after a Volkmann cuneiform and linear osteotomy of the tibia—a mortality of 9·37 + per cent.

Suppuration is reported to have occurred in 12 cases: Borchers,[7] Stephen Smith,[8] Hamilton,[9] Maunder,[10] two cases; Rodgers,[11] Maisonneuve,[12] Billroth,[13] Porter,[14] Margary,[15] Croft,[16] Moore.[17]

[1] "Med. Record," May 19, 1883, p. 541.
[2] "Arch. für klin. Chirurg.," 1882, p. 60.
[3] "Chirurg. Klin. Wien.," 1871–'76, p. 543.
[4] "Lancet," Dec. 22, 1877, p. 917.
[5] "Boston Med. and Surg. Jour.," April 18, 1878, p. 505.
[6] "L'Ostéotomie," Campenon.
[7] *Loc. cit.*
[8] "Med. Record," June 2, 1883, p. 589.
[9] "Ohio Med. Recorder," Aug., 1877, p. 97.
[10] "Trans. Clin. Soc.," London, vol. ix, p. 160.
[11] "New York Med. and Surg. Jour.," 1840, vol. ii, p. 238.
[12] "Gaz. Med. de Paris," 1847, p. 935.
[13] "Züricher Berichter," s. 552.
[14] *Loc cit.*
[15] "L'Ostéotomie," Campenon.
[16] "Trans. Clin. Soc.," London, 1877, p. 93.
[17] "Trans. Am. Surg. Association," vol. i, p. 111.

In Hamilton's, Rodgers's, Maisonneuve's, and Moore's cases, the operation was performed through a large wound, and before the subcutaneous method was adopted. In three patients there existed anchylosis of both hips. (Bryant, Ashhurst, and Hutchison, of Brooklyn.)

Cuneiform Sections.—Of these, 35 cases have been collected. Of these, in 27 the section was made between the trochanters; in 5 the section was made below the trochanter minor; in 3 the location was not stated—35. Of these, 28 recovered and 5 died. In 1 the result is not stated, and 1 is reported some years later as being in no better condition than before the operation.

In 9 cases suppuration is reported to have taken place, and in 22 no information is given with regard to this point. In 3, more or less necrosis is mentioned.

The cause of death was as follows: One reported by Weber,[1] from Bright's disease; one by Ders,[2] from exhaustive and excessive suppuration; one by Knorr,[3] from amyloid degeneration; one by Sayre,[4] from tuberculosis; and one by Lesrink,[5] from embolism—a mortality of 14·31.

There are reported 3 cases cured with motion; 21 cured, 1 improved, and 2 cured with anchylosis in a straight line. Three cases, from their subsequent history, can not be put down as successful.

Taking the whole number of cases analyzed of

[1] Rosmanit's Statistics, *loc. cit.* [2] Rosmanit's Statistics.

[3] Langenbeck's "Arch.," Bd. v., s. 479.

[4] "New York. Med. Jour.," January, 1869, p. 348.

[5] Rosmanit's Statistics, *loc. cit.*

osteotomy about the upper end of the femur, we find:

	Cured.	Died.	Failures.
68 sections through the neck	56	6	6
64 sections below the trochanters (linear)	54	6	4
35 sections, cuneiform	28	5	2
167	138	17	12

giving a mortality of 10·18.

It is also found that, of the fatal cases, twelve occurred prior to 1877, and only five after that date, the cases being very nearly equal in number in these two periods.

I think, therefore, that these tables taken alone are misleading in regard to the death-rate, which they make to appear much higher than it really is under the present method of management of wounds. It would appear that the fatal cases were most numerous in the earlier history of the operation, before experience had demonstrated what class of cases were proper ones for operation. For instance, in the fatal case of Mr. Croft, Mr. Adams, although at the time advising the operation, states later that his opinion was wrong. Other cases of deformity after hip-joint disease were subjected to an operation at too early a date after the acute symptoms had subsided, or the section was made too high. Another cause of the increased mortality was the improper method of operation.

Many of the earlier sections were performed through large wounds, and extensive dissections were often made to reach the bone. Osteotomy, as well as other operations which have suddenly become popularized, as it were, has suffered from a want of a clear understanding of the cases

suited for section and the faulty methods adopted, and the earlier operations have always contributed the greatest number of fatal and unrelieved cases.

In regard to the question, What operation should be performed? as mentioned before, cases of deformities following coxalgia are the most unfavorable for section through the neck, and, as a rule, the more severe the joint trouble has been, the farther from the articulation should the section be made. The existence of a neck is an absolute necessity in Adams's operation. The amount of real shortening is an index of the extent of its destruction in all cases, dislocations being excluded. It should also not be forgotten that in this class of cases an Adams may fail to correct, or the deformity may return. This has happened in at least four patients, and a section below the trochanter minor had to be performed.

Whether an operation above or below the trochanter minor will be the best, depends upon the amount of shortening of the muscles inserted at that point, and the extent of the disease that has existed in the hip joint. If there is marked contraction, a section above the trochanter minor will not, as a rule, correct the deformity.

Whether a simple or cuneiform osteotomy should be performed is, in my opinion, of little moment. The latter has been advocated in deformities accompanied by marked adduction of the limb. I think that a linear section will accomplish as much as a cuneiform. There will, of course, be a larger gap to be filled with new bone on the inner side than where a wedge of

bone has been removed. Theoretically, the latter may appear to be the better plan, but practically it makes no difference. The length of the incision, and the fact that a cuneiform osteotomy must be made through a large wound, does not add to the risk, provided the wound is treated properly.

A division of the femur performed after the method advocated by Dr. Stephen Smith has no advantage, I think, over a simple osteotomy. The tendency for the lower fragment to slip is not great; at least there has been no record, except in one case, of such an accident, which the tenon and mortise plan did not prevent in the case reported.

The operation has the theoretical objection of causing greater disturbance of the soft parts, and makes two partial sections of the bone. The abscess complicating the case should be attributed not to the operation, but to the lack of drainage.

Volkmann's excision of the hip joint by means of a chisel, as a substitute for "osteotomacia-subtrochanterica," has had but few advocates, both on account of the difficulty and tediousness of the operation, and the fact that but few cases are appropriate for the operation. The object aimed at is to obtain a movable articulation.

The question when an osteotomy should be performed is one not easy to answer. The liability of strumous joints to take on a new inflammatory action, from apparently slight injury, even some time after all symptoms of former trouble have disappeared, would indicate that some months should elapse after a "cure" before an attempt should be made to correct any malposition. Any pain about

the articulation should be a counter-indication against an operation.

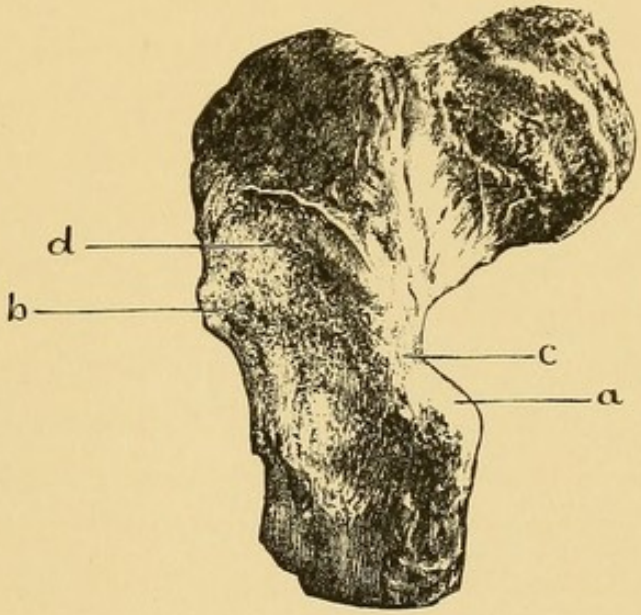
There have been but two recorded post-mortem examinations after an osteotomy at the upper end of the femur, one by Dr. E. M. Moore, of Rochester, and one by Dr. H. R. Wharton, of Philadelphia.

Dr. Wharton's case occurred in a patient nine years of age, who had suffered from hip-joint disease, and had recovered with the limb flexed at a right angle, with rotation outward and adduction. On November 25, 1882, Dr. H. R. Wharton made a subcutaneous section of the right femur below the lesser trochanter with a saw, which allowed the limb to be brought down into a good position; the usual dressings were applied, and in March, 1880, the patient was walking about the ward with the aid of a high shoe.[1] Some months later a swelling was noticed in the neighborhood of the great trochanter; this proved to be an abscess and was opened. From this time the patient grew rapidly worse, and finally died, August 15, 1883, from exhaustion. The fatal issue had no connection with the operation, but was due to a fall.

The specimen consists of the head, neck, and a portion of the shaft of the femur (Plates I and II). The head is denuded of cartilage, but otherwise does not show evidence of much disease. The section was made from a point midway between the trochanter major and minor downward and inward (*d c*, Plate I), so that the separation took place, as nearly as can be judged, in a line from this point

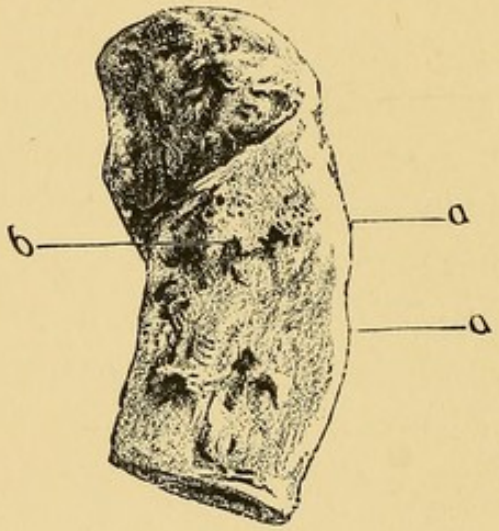
[1] "Am. Jour. Med. Sci.," July, 1883, p. 103.

PLATE I.



Dr. H. R. Wharton's case—the parts after an intertrochanteric operation, anterior view.

PLATE II.



Dr. H. R. Wharton's case—the parts after an intertrochanteric operation, lateral view.

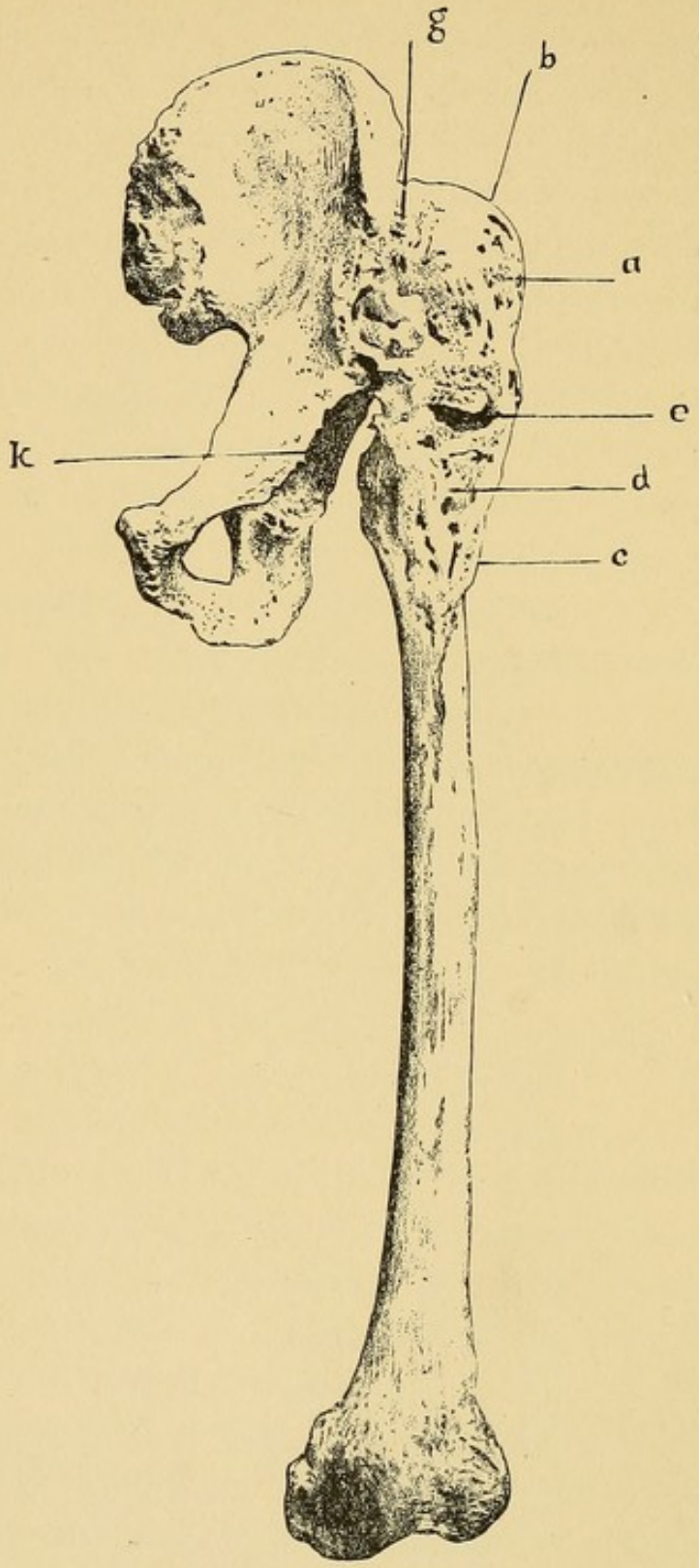
through the middle of the trochanter minor. There had been a sliding inward of the lower fragment, which has left a corresponding portion of the cut surface on the upper fragment *b* (Plate I), and also seen at *b* (Plate II), and a twisting outward on its longitudinal axis. The sloping projection (*a*, Plate I) is not due entirely to the displacement inward of the lower fragment, but in part to the rotation mentioned above. As the femur is much shorter in its antero-posterior than in its lateral diameter at this point, there would naturally be some projection when the lower portion was rotated outward to overcome the malposition due to the disease. From an examination of the cut, it is evident that the deformity has been corrected. The nature and amount of the correction are seen in Plate II. At the time of the operation there was left a V-shaped gap on the anterior aspect of the femur at the point of section; this has been filled up by new bone (*a a*, Plate II). It will be noticed that the outer line of the bone slopes inward, due to the sliding in this direction.

A careful study of this specimen shows the nature of the deformity after an osteotomy; it also shows how little is the shortening due to the operation. The displacement inward may have been due to the fact that the attachment of the psoas and iliacus were not entirely freed because the section was not made below the trochanter minor, but through it, and these muscles had drawn the lower fragment inward.

Dr. Moore's patient was an adult, in whom there existed a dislocation of the head of the femur on to

the ilium, just above the upper portion of the lip of the acetabulum. The dislocation was primarily backward on to the dorsum ilii, but by manipulation it had been thrown into the position mentioned above, with the head forward, just behind the anterior-superior spine of the ilium (*a*, Plate IV), and all attempts to dislodge it from this position failed. The foot pointed directly outward, at right angles to its normal position, and the limb was hyperextended, so that walking was extremely difficult. There was shortening of two inches and a half. An attempt was made to divide with a tenotome the bands that were supposed to prevent reduction, but the knife encountered bone that seemed to surround the head and hold it in its abnormal position. An incision was then made down upon the inter-trochanteric portion of the femur on its lateral aspect, and the bone divided with a metacarpal saw above the trochanter minor. After section, the limb was rotated inward, so as to bring the foot into its normal position, and extension by means of a weight of fifteen pounds applied, the object being to obtain a joint at the point of section. Passive motion was commenced early, but, notwithstanding persistent efforts, bony union was established, the shortening of the limb being reduced from two inches and a half to one inch. There was considerable suppuration, lasting some months, but finally ceased under the use of antisyphilitic treatment, the patient exhibiting a specific eruption. For some time he was able to get about comfortably with the aid of a cane. He died two years later from phthisis. Plates III and IV are from photographs of the specimen kindly furnished

PLATE III.



Dr. E. M. Moore's case—the parts after an intertrochanteric operation, anterior view.

by Dr. Moore. Plate III is an anterior and Plate IV a lateral view of the specimen.

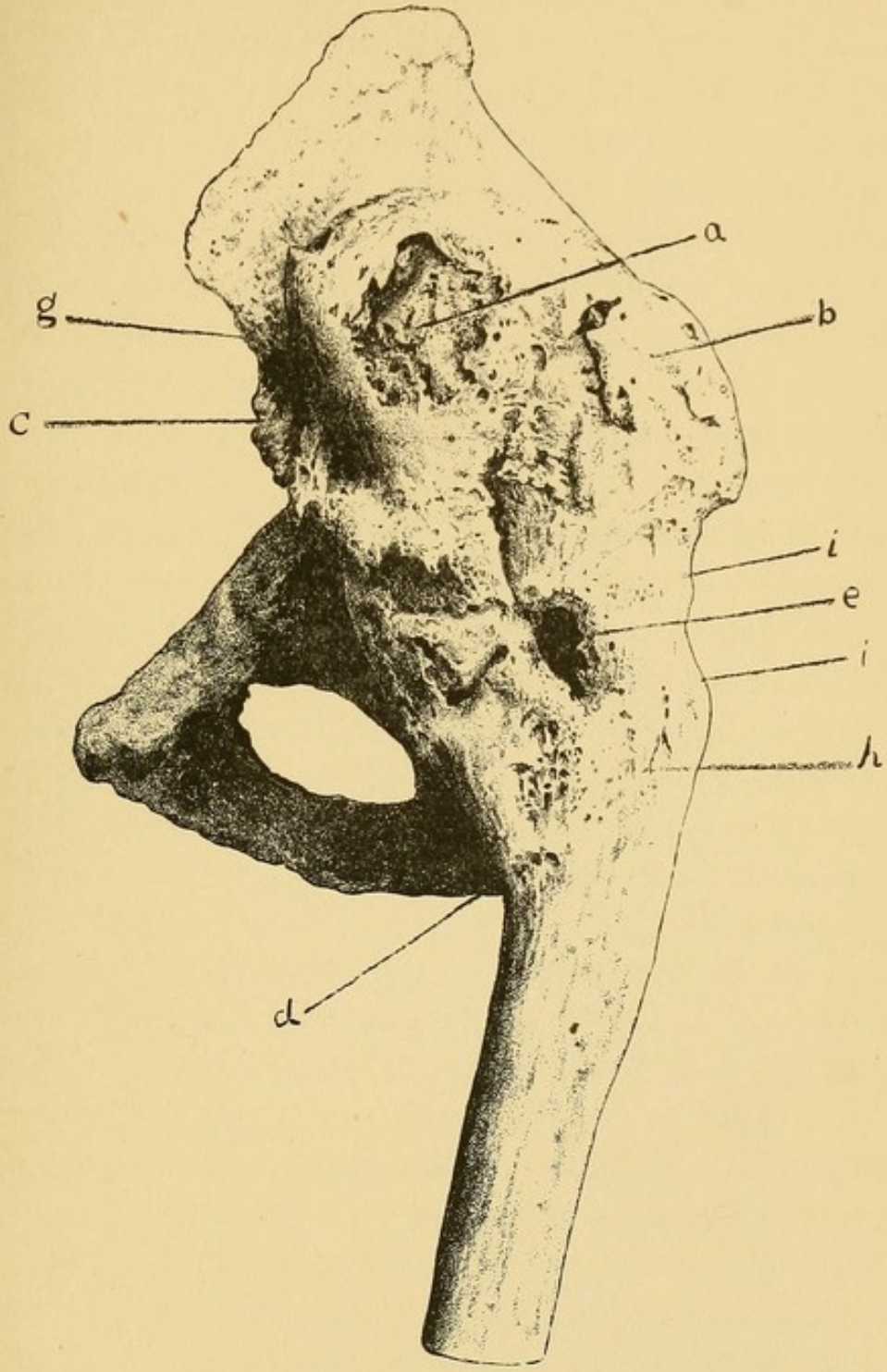
The head is dislocated and is seen (*a*, Plate IV) just behind the anterior-superior spine; the trochanter, covered in this situation with a shell of new bone, is posterior (*b*). The section was made midway between the trochanters, in a direction from without inward and a little downward, to a point just above the trochanter minor. The head is perfectly healthy. It is held firmly in its new position by a deposit of new bone (*b*, Plates III and IV), which covers it, except at one point (*a*, Plates III and IV) and the upper portion of the trochanter, and is continuous anteriorly below with the mass of new bone below the head, to be presently described, while above and in front of the head it is blended with the ilium (*g*, Plates III and IV). There is an enormous mass of bone, irregular in shape and perforated by many foramina, which springs from the anterior portion of the shaft from a point one inch and a half below the level of the trochanter minor (*d*, Plate IV) and extends upward and forward to a point on the ilium just below the situation of the head, where it is blended with the shell of bone covering the head (*c*, Plate IV). This mass is six inches and a half long, and is not intimately connected to the new bone forming the bond of union between the two fragments. A large opening is seen at *e* (Plates III and IV), at the bottom of which is seen the cut surface of the inferior fragment. The head is not directly united to the pelvis, but it is held by the new bone thrown out around it, the neck and trochanter major. This new bone is attached to the pelves at *g* (Plate III). The new formation uniting

the two fragments is one and a half inches long. It springs from the periphery of the lower fragment, and from the shaft immediately below it (*h*, Plate IV), leaving the upper extremity of the cut surface free. A little above this point it is compact, and at the point of attachment to the superior portion is blended with the shell of bone covering the head. The new bone by which the shaft has been lengthened is shown (*i i*, Plate IV). The acetabulum is perfectly normal (*k*, Plate III).

This case is remarkable in many respects, whether the dislocation, the enormous growth of bone, or the amount to which the shortening has been reduced is considered. The practical question is whether, in such cases, a lengthening of the limb is possible, and if so, what is the best method of accomplishing this end?

The growth of bone about the head and neck was entirely independent of the operation, and existed at the time of its performance. The outgrowth, from a point below the level of the trochanter minor and extending upward in front of the femur, to be attached to the ilium, could not have existed at the time of the section, otherwise the position of the limb could not have been improved. It would seem probable, as Dr. Moore suggests, that in some individuals there is a predisposition for the growth of stalactites about the hip joint, and that this abnormal development of bone about these parts in the patient from whom the specimen was taken may be attributed to this predisposition. Whether the presence of a specific taint had anything to do with its production is an interesting question, but one which can not

PLATE IV.



Dr. E. M. Moore's case—the parts after an intertrochanteric operation, lateral view.

be solved. I do, however, think that, given the predisposition to exuberant bony formation, the persistent use of passive motion, in order to prevent bony union between the fragments, kept up an irritation of the parts which in this individual contributed to the development of bone in its abnormal position, and to the extent in which it was found. The limb, after consolidation, was adducted to a considerable degree, and could not have been as useful as one in a straight line or slightly abducted.

The ultimate results of all attempts to obtain a false joint at the point of section have not been very encouraging, as none have been followed by permanent success. In Barton's case, section between the trochanters, in which the operation was performed with this end in view, the patient had useful motion for six years. He then became dissipated, and the joint gradually became stiff, and, at post-mortem examination two years later, was found to be anchylosed. In Dr. Sands's case[1] (Adams) the patient for a time (two years) had a fair amount of motion. He then became dissipated, and the false joint gradually became stiff. Two cases are reported by Lund. There is no history beyond sixteen months. In two other cases (Sayre's) of cuneiform osteotomy one patient is reported to have had a considerable amount of motion at the time of dismissal, but later report[2] is to the effect that suppuration had taken place and terminated in immobility at the point of section. In the other case the patient died at the end of six months, and a false joint was demonstrated. There were,

[1] "New York Med. Jour.," vol. xviii, p. 609.

[2] "Med. Rec.," 1878, p. 174.

however, necrotic changes taking place in the bone about the new articulation.

It would seem that the difficulties attending the formation of a false joint are great, and, even if one is obtained, it is a question whether it is of any real advantage to the patient. I do not think that a false point of motion at the upper end of the femur is an advantage. In this connection Dr. Sands expresses the following opinion: "The question whether operation of this character may be expected to result in the formation of an artificial joint is not, in my judgment, a very important one. If the affected limb can be restored to its normal position and to nearly its normal length, anchylosis will be found, I think, to afford greater security than the best false joint, and to offer no serious obstacle to locomotion."

It would appear that, in those cases in which motion at the point of section persisted for some time, it was more of a hindrance to locomotion than an anchylosed limb. Further, from the fact that the tendency is toward a final anchylosis, it would seem that the time lost in the attempt, and the necessary suffering in trying to prevent the limb becoming stiff, were worse than useless.

The ultimate result of osteotomy in the upper portion of the femur as to the use of the limb is excellent.

In forming an opinion in regard to the advisability in any case of performing an osteotomy, the amount of adduction should be considered more than the flexion. I think that we are apt to look more at the latter while the former condition is the main hin-

drance to easy locomotion. I think that a moderately flexed limb, with much adduction, is more of a real deformity than one flexed to a much greater degree without adduction.

Case II illustrates this point. The actual shortening was one inch, the real shortening (and by that I mean the distance of the foot from the ground while walking) was more than two inches, the tilting of the pelvis on account of the adduction causing the additional amount of shortening.

There is still another class of cases of deformity after hip-joint disease in which an osteotomy may be performed with advantage. I refer to cases of marked flexion and adduction of the thigh due to shortening of the psoas and iliacus, and the adductors in which further flexion is possible, but extension beyond a point can not be obtained. There is no doubt but that quite a number of cases belong to this category. Some of them can certainly be relieved by extension upon an inclined plane, or by a tenotomy the adductors can be freed, but I am satisfied that all cases can not be relieved by this method. I have failed in some cases. Among the poor it is impossible to carry out with any degree of satisfaction the necessary treatment. In these cases a section below the trochanter minor is justifiable. It certainly can not be attended with much if any danger, and, although it will add a little to the real shortening, it will increase the apparent length of the limb and allow the patient to plant the foot firmly on the ground without any great amount of arching forward of the lumbar vertebræ (lordosis). I have never operated upon such a case, but can see no possible objection

to it, and would certainly do so did an opportunity offer.

On the management of the limb after the section depends the success of the operation. Various methods have been adopted, as extension, putting the whole limb up in plaster-of-Paris, a long splint, etc. I think that extension and a long splint extending from the axilla to the foot, with an angle opposite the point of section, so that the limb may be held in a slightly abducted position, is by far the best, and plaster-of-Paris the worst dressing that can be used. With the latter, displacement of the lower fragment is liable to occur, and the pelvis to become twisted, and there is no opportunity to rectify any malposition. The case reported by Dr. E. M. Moore[1] demonstrates the advantage of extension in these cases. I have in a recent case adapted this plan of treatment, and have reduced the amount of shortening to a considerable degree.

ACCIDENTS.

Except suppuration and necrosis, but few accidents have been reported.

Hæmorrhage, as a rule, is slight, and even in those sections that have been made through a large wound it was seldom that a ligature was required.

In two cases serious consequences followed from pressure on the femoral vessels.

Post[2] mentioned a case in which he had made a section of the femur just below the trochanter minor

[1] "Trans. Am. Surg. Assoc.," vol. i, 1883, p. 111.

[2] Report of "Trans. N. Y. Surg. Soc.," "Annals of Anat. and Surg.," January, 1883, p. 30.

through a large wound. The limb became gangrenous and the patient died. At the autopsy it was found that the great vessels had become caught over the upper fragment of the bone, and in that manner the circulation in the limb had been impeded.

Servais[1] reports the case of a man, twenty-three years of age, on whom he had performed an Adams's operation. No accident occurred at the time, but on the twentieth day profuse hæmorrhage took place from the femoral artery or one of its large branches, due to pressure of one of the fragments. The femoral was ligated and recovery took place. Maisonneuve is reported to have divided the sciatic nerve during an operation of section between the trochanters.

Operations upon the femur for the correction of deformities after fracture have, until within the last ten years, been attended with great danger and a high rate of mortality. Fractures of the femur are more apt to be oblique than are similar injuries of the bones of the leg, and, when vicious union occurs, the deformity is due not only to bending at the seat of fracture, but there is a much greater amount of shortening, due to overriding of the fragments, than after similar injuries to the tibia. They are therefore not as easily corrected, and a more severe operation is necessary. Out of twenty-five cases, in nine the ends of the bones were resected after a simple division; of these, suppuration is reported to have occurred in seven. Four patients died—three from pyæmia, one from shock after an amputation of the limb, and five recovered. In seven a wedge-shaped piece of bone was removed at the seat of fracture; of these, suppu-

[1] "Rev. de Chir.," December, 1881, p. 1043.

ration took place in three limbs; two patients died —one from pyæmia and one from exhaustion, and five recovered. In nine a simple section was made. Two cases of suppuration are reported; two died— one from pyæmia, and one from shock twenty-four hours after the operation, making a total of twelve cases in which suppuration occurred, eight deaths and seventeen recoveries—a mortality of 32 per cent. In one case, where there was much overriding of the fragments, Fitzgerald[1] divided the callus longitudinally with an osteotome, and then, by applying extension, brought the lower fragment down and corrected the shortening. In some cases great extending power has been applied by means of pulleys; it is not, however, unattended with danger. Horner,[2] after excising the ends of the fragment, brought the lower fragment down by means of compound pulleys. He accomplished his purpose, but gangrene of the limb set in, and the patient died on the fourth day. The greatest mortality occurred before the antiseptic method of caring for wounds was known. Since 1876 I can find no fatal result reported. Where, from the nature or the position of the fracture, osteoclasis can not be performed and a section is necessary, the choice of the operation is not an arbitrary one. In many cases a linear osteotomy will not yield the best results; the angular deformity can certainly be corrected, but, when there is much overriding and consequent shortening of the limb, it is necessary to separate the bone in the line of the fracture, and often, in addition, to excise the ends of the fragments which

[1] "Austral. Med. Jour.," 1879, N. S., vol. i, p. 168.

[2] "Med. Exam.," Philadelphia, 1851, N. S., vol. vii, p. 32.

may have become rounded off and require to be freshened in order to obtain bony union, or the removal of a segment of bone may be necessary to bring the ends of the bone into apposition. It is probable that cases requiring correction after fracture of this bone will be rarely met, and that, with increased facilities and a better knowledge of the management of these injuries, perfect, or nearly perfect, results will be obtained in the vast majority of cases.

ILLUSTRATIVE CASES.

CASE I.—H. B., ten years of age, was admitted into St. Mary's Hospital with deformity of the right hip joint following suppurative disease of that articulation. He has had caries of the spine in the middle dorsal region from which he has recovered, but with marked deformity. Three years ago the right hip joint became diseased, an abscess formed behind the great trochanter, and continued to discharge for some months. The limb gradually became flexed and adducted, so that at the time of admission it was in the condition shown in Fig. 12. On ex-

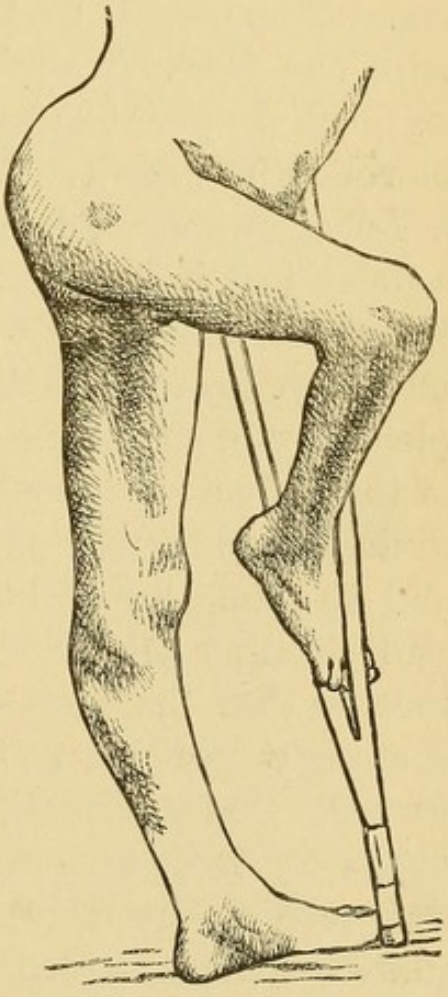


FIG. 12.

amination, the upper portion of the femur is found to be dislocated on to the dorsum of the ilium; the adductors are strongly contracted and very tense. There is a great amount of lordosis, but I think much of it is due to the spinal deformity. When placed on his back and the pelvis brought into its normal position, the limb is flexed at a right angle to the pelvis, and crosses the left at a point above the knee. There is no motion between the femur and pelvis.

In January, 1883, the following operation was performed: An incision was made about three inches long, extending from the middle of the trochanter major downward, so that its center corresponded with the trochanter minor. The bone was found to be much deeper than normal, the muscles seeming to be rolled up over it. The periosteum was raised and a V-shaped piece of bone removed with a chisel from a point just below the trochanter minor, the apex of the wedge extending into the compact tissue on the inner aspect of the shaft. The section was then completed by an osteotome. As much of the attachment of the adductors as could be safely reached was then divided; also a portion of the tensor vaginæ femoris, and the long head of the rectus. As the limb was still strongly adducted, other resisting bands were torn so that the limb could be brought down into a straight position as far as the adduction was concerned. There was still marked lordosis, which was evidently due, to a considerable extent, to the spinal deformity. The edges of the wound were partially united, leaving a central portion open. Iodoform, and a compress secured with adhesive plaster, com-

pleted the dressing. A long splint extending from the axilla to the foot, an extension-weight of five pounds was applied after the patient was in bed. The wound was some time in entirely closing. The patient was up in about five weeks. Fig. 13 is from a photograph recently taken. There appeared, a few days after the operation, considerable ecchymosis, extending over the lower portion of the abdomen, down into the right scrotum and the perinæum of the same side. A vessel of some size must have been torn in bringing the limb into position, as the tissues gave way with considerable noise.

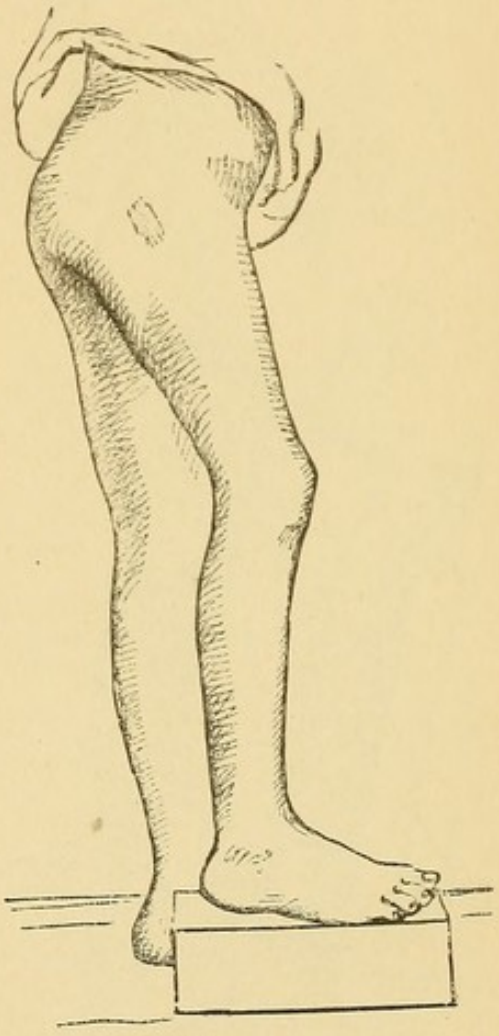


Fig. 13.

Case II. — B. K., eleven years of age, had disease of the left hip joint three years ago, following a severe injury. An abscess formed on the outer aspect of the thigh. At the time of admission she had not worn a brace for eight months. The limb is found to be flexed on the pelvis at an angle of 140° and strongly adducted. There is no motion at the hip joint. The limb is one inch short. She walks with a very awkward gait, her toes only touching

the ground, as, on account of the adduction, she has to raise the pelvis on the diseased side so that it increases the apparent shortening to two inches. Fig. 14 shows the amount of flexion. In February, 1883, a simple osteotomy was performed just below the trochanter minor; the adductors and long head of the rectus were divided, but the limb was not disturbed much, nor any persistent attempt made to correct the abnormal position. The lips of the small wound were brought into apposition with a narrow piece of adhesive plaster, and over this a compress. A long splint and five pounds extension were applied. On the third day the extension-weight was increased to ten pounds, in order to stretch the muscles and adhesions so as to bring the lower fragment down and thus overcome the adduction and flexion. This was accomplished two days later. On removing the weight, it was found that the adduction had entirely disappeared, and the lordosis was much diminished. The weight on the extension-plasters was reduced to five pounds. At the end of five weeks the patient

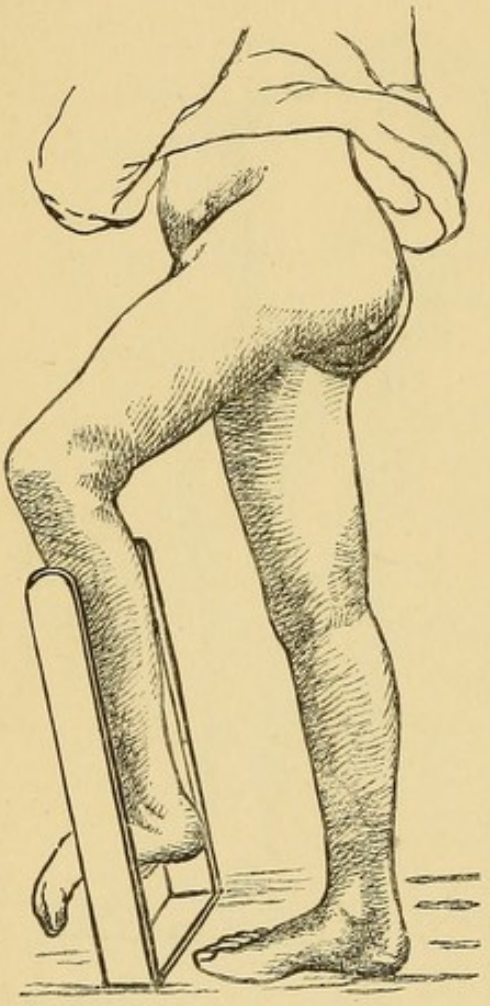


Fig. 14.

was allowed to get up. At the time of dismissal she walked well with a shoe one inch high, without the awkward swinging gait which she had at the time of admission (Fig. 15). In both of these cases the temperature at no time was over 99°.

I have given these cases in detail because I wish to emphasize certain points in the operation and after-treatment which seem an advantage. I think that it is better not to make any attempt to correct the flexion and adduction by forcibly moving the limb in different directions in order to stretch the resisting bands and muscles. The necessary friction between the fragments is certainly not an advantage. The less the parts immediately about the bone are disturbed the better, and the less liability there is for inflammatory processes to be set up. By extension with a weight of from ten to fifteen pounds, according to the age of the patient, the muscles and bands of adhesion can be lengthened in a day or two, and, when this is accomplished and the extension let up, it will be found that the limb can

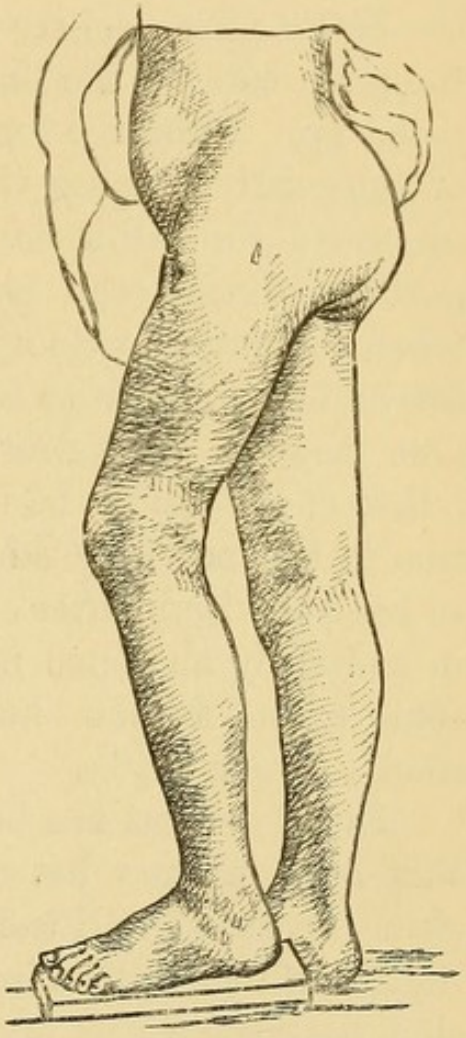


Fig. 15.

be placed in any desired position without pain. There certainly is a danger that the soft parts may get pinched between the fragments and be the starting-point of suppuration. At all events, it is a precaution in the right direction; it will certainly accomplish the purpose as well as twisting the limb while the patient is under ether, and it would seem the better plan. There is liability for the pelvis on the same side as the limb operated upon to become tilted up. From the long habit the patient has had of constantly keeping the pelvis raised in order to overcome the adduction, it will assume the same position during the period of consolidation, and, when the patient gets up, the limb is found more or less adducted, much to the annoyance of the surgeon. One may be easily deceived by the apparent parallelism of the limb, while in fact the limb in its relation to the pelvis is adducted. It is an advantage to have the limb, after consolidation has taken place, in a slightly abducted position, as it compensates to some extent for the shortening, and enables the patient to walk better.

The statement has been made by some operators that after section between the trochanters the patient "possessed all the movements of the normal limb." If by this it is intended to convey the impression that there was active motion, I can not understand the statement. Quite a number of large muscles have their origin and insertion above the point of section, they are so placed for a purpose, and that is to act on the femur. Now, if section is made below their point of insertion, they certainly can not have any effect on the motion of the limb. I do not

think that useful motion is probable after a section between the trochanter and possibly below the trochanter minor, and I believe that a patient is much better off after an osteotomy for the correction of deformity at the upper portion of the femur with firm union between the fragments, no matter whether the section be at the neck, between or below the trochanters.

CHAPTER IV.

GENU VALGUM; ITS ETIOLOGY AND PATHOLOGY.

Definition.—A deformity at the knee joint in which a line drawn from the head of the femur to the middle of the ankle joint passes outside the center of the knee joint, and in which the internal malleoli can not be made to touch when the limbs are in an extended position.

In discussing the pathology and etiology of knock-knee, it will be necessary, in the first place, to clearly define what class of deformities belong to this category. Not all cases of separation of the feet and approximation of the internal condyles of the femur are to be classed as knock-knee. In other words, not all cases of in-knee are cases of true genu valgum. If we examine a case of true knock-knee we find that the anterior surface of the femur is directed forward; the feet point outward or forward to a greater or less degree, never directly inward. In uncomplicated cases, when the legs are *fully extended* on the thigh, the inner surface of the knees are in contact, while the internal malleoli are more or less separated, according to the degree of the deformity. And, on flexing the leg on the thigh, the knock-knee disappears. This is true genu valgum. A condition that at first sight resembles this is

seen in cases of spastic contraction, in some cases of disease of the knee joint, and in a few examples of coxalgia in its later stage. The whole limb from the hip joint is rotated inward, the knee is flexed more or less upon the thigh, and the feet are turned inward. In these cases it is often impossible to fully extend the leg on the thigh on account of the

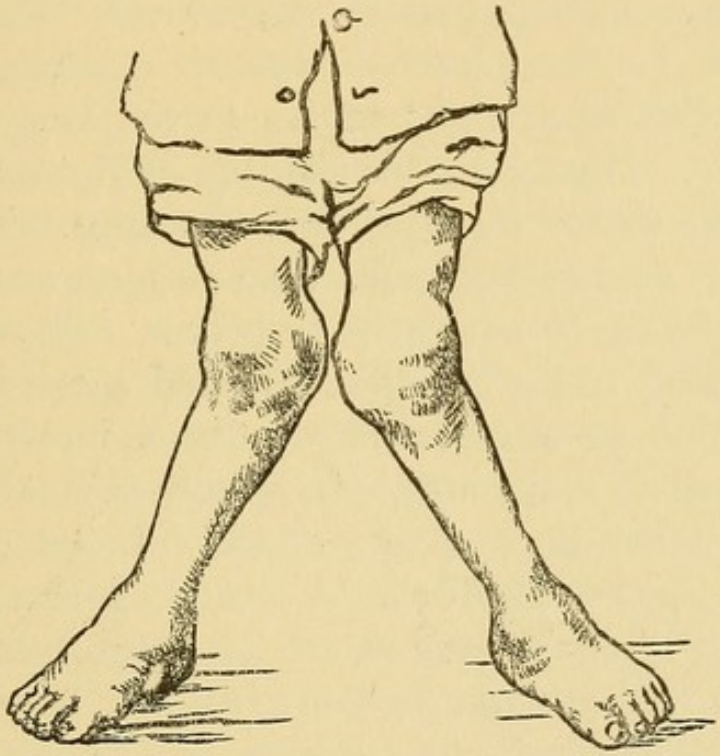


Fig. 17.

contraction of the muscles on the posterior aspect of the thigh and leg. They are no more cases of knock-knee than they are cases of talipes varus, simply because the toes point inward. They are often cured in a short time by tenotomy and appropriate apparatus. Patients with this deformity almost always walk on the toes. Any one can readily make his limbs assume such a position.

Fig. 17 is from a photograph of a patient with

genu valgum, and is a good illustration of an uncomplicated case.

If a perfectly normal adult femur be disarticulated and examined, it will be found that, when the bone is held perpendicularly, the internal condyle occupies a lower plane than the external, being about one half of an inch longer; but when the bone is articulated, the femur is found to slant inward so that the condyles are on the same level. This must needs be, as the plane of the articulating surface of the tibia is at right angles to the long axis of the body. Owing to this slanting of the femur, the knees are nearer together than the hips. This obliquity is greater in women than in men, on account of the greater breadth of their pelves. There is also an entering angle, the apex directed inward at the knee joint in the normal condition, more marked in women than in men. In a normal condition of the limb the inner aspect of the internal condyles and the inner malleoli can be brought together when the leg is fully extended on the thigh. In a case of genu valgum the malleoli can not be made to touch, while the inner condyles are in contact. In some few cases of genu valgum there is some flexion of the leg, due to contraction of the biceps. This is not a primary condition, but is secondary, and is due to the fact that the patient endeavors to stiffen and steady the knee joint by contraction of this muscle in walking.

The knee is the largest joint in the body, and yet it is the weakest. The strength of the joint lies not in the bones, but in the number and size and arrangement of the ligaments which unite the bones, and in

the powerful muscles and fascial expansion that pass over the articulation (Morris). It is a joint that is subjected to a great amount of strain; the bones of whose extremities it is formed exert, from their length, an immense leverage. This is a great element in the production of deformities, and, at the same time, the chief aid in their mechanical treatment.

Three theories have been advanced to explain the production of genu valgum, namely: the ligamentous, the muscular, and the osseous.

Those who adopt the ligamentous theory attribute knock-knee to contraction of the external and relaxation of the internal lateral ligaments of the knee joint. But the anatomical fact that ligaments are placed to limit motion, and have not the histological elements in their composition to enable them to undergo active contraction, militates against this theory. The condition of the ligaments in genu valgum varies. Sometimes they are relaxed. In some cases they retain their normal condition. In others the external will be relaxed while the internal hold the inner condyle and head of the tibia in close apposition—just the reverse of what the advocates of this theory assume to be the case. In some cases the external ligaments, as well as the crucial, are so much relaxed that the leg can be brought into a line with the axis of the femur without the use of any force. They therefore can not be an active agent in the production of genu valgum. Section of the ligament has been found to be useless in the treatment of this deformity.

Contraction of the biceps has been assigned as the cause of knock-knee. It is difficult to understand why this muscle alone should be contracted,

as it is supplied by the same nerve as the other muscles at the back of the thigh. In many cases it is found in the same condition as the semi-membranosus and semi-tendinosus, neither relaxed or contracted. Its division has not been followed by correction of the deformity. It is true that in some cases it is found contracted, together with the fascia; but it is a secondary, not a primary, condition.

In 1792, Büttcher[1] drew attention to the fact that in genu valgum the internal condyle occupied a lower plane than the external when the femur was in its normal position; and Mr. Bishop, in his work on deformities, states that "the inner condyle becomes disproportionately larger and altered in figure." Yet this fact seems to have been overlooked, or, from a feeling that it was impossible to remove it, was allowed to be forgotten.

The osseous theory of genu valgum is now universally adopted, namely, that all cases of knock-knee are due to alteration in the shape of the bone about the knee joint. There are three kinds of genu valgum: A femoral, in which the deformity is due to changes in the relation of the condyles of this bone; a tibial, in which the malposition of the leg is due to changes in the plane of the tibial heads; or the articular ends of both bones may be altered so that both contribute to produce the deformity.

Femoral Variety.—The plane of the femoral condyles can be changed only in three ways, namely:

1. By increased growth.
2. By the bending of the lower third of the shaft.
3. By atrophy of one of the condyles.

[1] "Brit. Med. Jour.," July 6, 1879, p. 1.

If the lower end of a perfectly normal femur be examined on a living subject, it will be found that, when the leg is strongly flexed on the thigh, the lowest portion of both condyles can be readily made out, and, if the thigh be held in its natural position, it is very easy to judge of the relative lengths of the two condyles. While the limb is held in this position a narrow piece of sheet lead can be molded across the joint, and from this a correct outline of the articular end of the bone can be obtained and traced on paper. That the internal is in some cases increased in length,

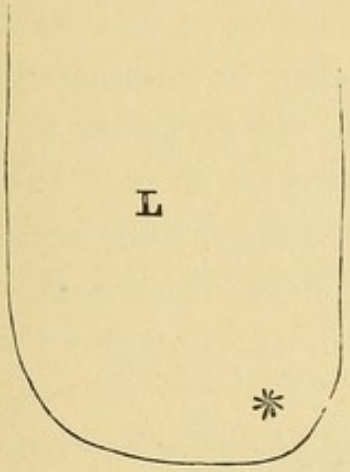


FIG. 18.

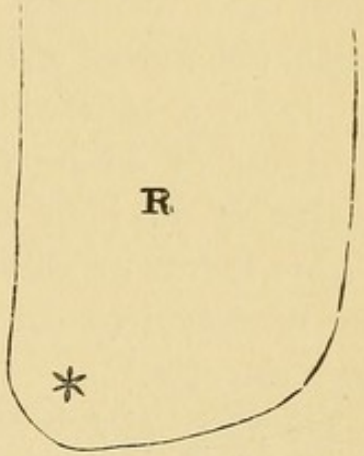


FIG. 19.

and thus occupying a lower plane than the external, has been demonstrated by post-mortem examinations and recorded by Delore, De Santi, Lannelongue, and others.

Figs. 18 and 19 are from a tracing of a case of unilateral genu valgum, showing the difference in the position of the internal condyles in the two limbs. The * indicating the position of the internal condyle.

Dr. Clark demonstrated the same fact in a careful measurement of one hundred and sixty-six limbs

(belonging to one hundred patients) affected with knock-knee, and, comparing them with one hundred measurements of normal limbs, in seventy per cent there was an abnormal increase of the internal over the external condyle. Allowing that in the normal limb the internal condyle averages about one quarter of an inch over the external condyle, all above this was considered abnormal. In persons under ten years of age there would be less difference between the length of the two condyles than one quarter of an inch. This would raise the percentage to over eighty-four. Of the one hundred and seventeen cases in which the internal condyle was over the normal length, the extent of the abnormality in fourteen cases was under a quarter of an inch. In fifty-four it was a quarter of an inch. In thirty-five it was over a quarter of an inch and not more than half an inch. In nine it was between a half and under an inch. In four it measured an inch, and in one it was an inch and a quarter.[1]

De Santi states that the hypertrophy is confined to the vertical diameter of the condyle. Guéniot found the same condition, but with an evident diminution in the antero-posterior diameter.

I have also noticed, together with an evident increase in the length of the condyle, a spur-like growth from its inner surface, extending beyond the line of the tibia.

A curvature of the lower third of the femur with the convexity inward will cause a depression of the internal and an elevation of the external condyle. Or it may be looked upon as a tilting of the lower end of

[1] Macewen, "Osteotomy," p. 44.

the bone in a direction from within outward and upward. In the majority of cases in which the deformity appears early in life I have generally found it due to the bending of the bone; in addition to this there may be a change in the epiphysis. It is not placed squarely on the diaphysis, but is twisted more or less, the cartilage is thickened, may be, over the internal condyle, while that over the external portion of the bone may be flattened and crowded out over the epiphysis. The latter is due to the weight of the body acting upon the softened bone.

There is yet another change met with at post mortem, and which is a cause of this deformity, namely, a flattening of the external condyle; or it may undergo a true atrophy.[1]

From a plate in Delore, it is evident that the femur may be bent near its neck so as to throw the trochanteric and subtrochanteric portion of the shaft outward.

The femur often has an anterior bend.

In not a few cases of knock-knee a careful examination reveals nothing abnormal in the shaft of the femur or its condyles, the latter being in the same plane; but the articulating surfaces of the tibia are not on the same level, the inner head of the tibia being on a much higher level than its external, thus throwing the axis of the tibia outward, or the diaphysis of the bone may be united to the epiphysis at an angle.

Often the deformity in genu valgum is due to changes taking place in both the femur and tibia.

I have never met with a case of true genu valgum that was not due to osseous changes.

[1] Howse, "Guy's Hosp. Report," vol. xx, p. 531.

These changes in the shape of the bones are, in a certain class of cases, often accompanied by other curves of the long bones of the lower extremities. It is evident that in many cases of the deformity one factor can not be assigned as the sole cause of the the malposition of the tibia.

The condition of the ligaments about the knee joint in genu valgum varies. Often there is no change except such as is secondary to the deformity —namely, a lengthened internal lateral ligament, corresponding to the increased size of the condyle; but there is no relaxation. Sometimes the external ligament is very much relaxed, so that the tibia can be brought into a straight line with the long axis of the femur without the use of any more force than is necessary to move the limb, an interval being found between the external condyle and the corresponding point of the tibia. Both ligaments, together with the crucial, may be so much lengthened that the leg can be moved very freely in both lateral directions. Too much force applied during mechanical treatment has been the cause of this lengthening of the external ligament in some cases.

It is evident from this that the condition of these structures varies, and that they can have no direct cause in the production of the deformity.

Such being the changes found in the bones in genu valgum, the next inquiry is as to their cause.

There are two periods during which knock-knee is first developed: namely, in children between the first and fifth years of age, and in young persons between the twelfth and twentieth years, the first corresponding to the term during which diseases of

malnutrition are so common, the second to the period of rapid growth. Between these two dates—namely, from the sixth to the twelfth year—genu valgum is rarely developed. The etiology of the deformity in these two periods differs.

In genu valgum coming on before the fifth or sixth year, rickets is the predisposing cause. I have never seen a case of the deformity in a child under six years of age in which there was not unmistakable signs of this disease. In a perfectly healthy child—one who has been properly nourished and has breathed pure air—knock-knee will not be developed; at least I have never met with such a case, nor do I know of any recorded example of this deformity appearing. Normal bones do not become distorted.

The case is, however, different in children who have been improperly nourished and who have lived in bad hygienic surroundings. Those who have been brought up under such circumstances develop these deformities. At this age, and at the time of the greatest intensity of the rachitic changes in the bone (softening), any alterations in the shape of the shaft of the femur or in the articulating ends of the bone and the tibia may occur. Tripier advances the theory that the epiphyseal cartilage first becomes thickened and the limb lengthened, and later the weight of the body determines the bend, according as the intensity of the softening has fallen upon the epiphyseal cartilage or the shaft of the bone. The immediate cause is mechanical. In children who are too young to walk, the manner in which they are carried about has been assigned. In fact, any posi-

tion that can act on the soft bones may cause them to bend. Cases have been recorded of congenital genu valgum.

The cause of genu valgum coming on after the twelfth year has given rise to much discussion, and has received many explanations. Macewen, in his admirable work on osteotomy, considers that the deformity, as in the infantile variety, is due to rickets, and gives the histories of three cases in proof of his statement. In one, profuse perspiration about the head, curvature of the long bones of the lower extremities, swelling of the epiphyses of the forearm, and marked bow-legs, came on in a lad of fifteen years of age, who, previous to this attack, had been perfectly healthy. The other two cases are not given with sufficient detail. The author simply states that they developed knock-knee, preceded by a train of symptoms only referable to rickets. The history of the first case certainly corresponds to that of rickets. But whether all cases of genu valgum coming on after the twelfth year should be considered as due to this disease, I doubt. It is true that other writers have maintained the advent of rickets during adolescence, but these statements have been questioned by many able observers.

My own experience is limited to four cases, but, as they seemed to throw some light on this subject, it may be of interest to record them. For the use of these cases I am indebted to my friend, Dr. Gibney.

Case I.—F., fourteen years of age, has always been delicate; is now in fair condition; for the past year has been growing rapidly. No symptoms of rickets,

past or present, can be detected. Within the last eight months a double genu valgum has been developed. Both internal condyles are on a lower plane than the external. There is no abnormal bend of either femur or tibia, no tenderness over the line of the epiphyseal cartilage, and no enlargement of the ends of any of the long bones.

Case II.—M., seventeen years of age, has always been healthy. For the past year has been employed as a wagon driver for a groceryman. Has had to jump out of his wagon very often, and always coming down on his left foot. For the past year has been growing very rapidly. Two months ago he noticed that in walking his left knee bent inward. The patient is muscular and well developed. He has never had any perspiration about his head, nor any other rachitic symptoms.

On examination, he is found to have knock-knee in the left limb. There was no abnormal bending in either the femur or tibia, no enlargement of the ends of the long bones. The condyles of the left femur are on the same plane, but the inner head of the tibia is much higher than the outer, and is evidently the cause of the abnormal position of the leg. The ligaments are normal.

Case III.—M., sixteen years of age, is well developed and muscular. He has always been healthy. For the past two years has been employed in a factory where he has to stand all day and swing a heavy mallet. He is certain that his limbs were perfectly straight until three months ago, when they began to bend inward at the knee. This bending inward has been increasing. He has been free from pain until within

the last week. Since then has suffered considerably after standing or walking. The left limb is more deformed than the right.

Left Knee.—There are two spines—one two, the other three inches below the inner head of the tibia on the lateral aspect. They are quite tender upon pressure. The line of the epiphyseal cartilage of both the femur and tibia are tender on pressure. There is some lateral motion at the knee joint. There is effusion into the left knee joint, and it measures one inch more in circumference than the right.

Right Knee.—There are two spines in the same position as those in the left, but smaller and not so tender. The joint is not swollen; the epiphyseal line of both bones is tender. The condyles of both femora are on the same planes, while the inner heads of both tibiæ are higher than the external. There are no symptoms of rickets, either in bending of long bones or enlargement at their extremities. Patient states that he has increased six inches in height during the past year. He weighs 164 pounds.

Case IV.—M., nineteen years of age, baker, states that he has always been healthy. Is rather young-looking for his age. He first noticed that he was becoming knock-kneed nine months ago. Both limbs are œdematous, and feel flabby. The condyles of both femora are perfectly normal in position. The shafts of both tibiæ seem united to the epiphysis at an angle. The articular ends of these bones are on a level. There is no tenderness anywhere about the joints. There is slight lateral motion at both knees. The tarsal arch is flattened. The deformity is evidently

tibial. The patient has been growing rapidly during the past year. His work compels him to stand most of the night with his leg adducted and knees slightly flexed.

These four cases have one thing in common: that the deformity developed during rapid growth. In three it occurred in persons who gave no history of any illness, and, with the exception of the deformity, two of them would have been considered as types of healthy development. There were certainly no signs of rickets. In two cases the deformity was due to position—standing during long working-hours—in the other, jumping frequently from a wagon, and always alighting on the same limb.

It is a well-known fact that the increase in the length of the lower limbs takes place to a great degree by deposit of new material between the diaphyses and epiphyses of the femur and tibia. If the formation of new bone elements (cartilage-cells) is more rapid than the ability of the system to supply the earthy salts for their calcification, this new material would be liable to yield in any direction under persistent force. This, I believe, is the explanation of the advent of the deformity in the cases mentioned above. That this increased activity of formative process was great is evidenced in growth of spine over the tibia, and the effusion into the knee joint. Tenderness on pressure over the epiphyseal cartilage adds weight to the view.

In regard to tibial spines, Macewen states that they are a prominent feature in many cases of knock-knee; that they are more frequently found in infantile cases than in genu valgum adolescentium. He

gives the percentage as high as sixty-nine. I have never met with them except in the case given above, although they have been looked for. They must be of much less frequent occurrence here than among the children coming under that gentleman's observation.

The cause of abnormal increase in the internal condyle has never been satisfactorily explained. Whether the theory of increased nutritive activity in the epiphyseal cartilage over the condyle is the correct one has never been proved.

Genu valgum is seen after convalescence from disease, as typhoid and scarlet fever. The deformity has been known to develop during rheumatic fever, but the pathological process has never been recorded. Gould[1] exhibited, at the London Pathological Society, a specimen removed by amputation, in which, together with obliquity of both epiphyses, there were marked symptoms of rheumatic arthritis. Haward[2] mentions a case in which marked hypertrophy of the external condyle was found in a knee joint affected with rheumatism. Richardson[3] demonstrated the intrinsic enlargement of the condyle from disease. I have never seen a case of true knock-knee in disease of the knee joint, although a great many joints have been examined for this purpose. There is often an appearance resembling this deformity, but I have never been able to satisfy myself that true knock-knee existed.

Morris[4] mentions the case of a boy who, some years before, injured the upper portion of his tibia.

[1] "Brit. Med. Jour.," January 21, 1882, p. 87.
[2] "St. George's Hosp. Report," 1879, p. 466.
[3] "Med. Press and Circ.," 1879, xxvii, p. 322.
[4] "Brit. Med. Jour.," May 21, 1881, p. 809.

This was followed by necrosis. At the time of observation the inner head of this bone was found greatly enlarged, so that it occupied a higher plane than the external, producing well-marked genu valgum of the limb.

Beauer[1] records a case of genu valgum, due to diastasis of the lower epiphysis of the left femur subsequent to an injury, in which the lower portion of the bone had become dislocated outward, and for the correction of which excision of the knee joint was performed.

A case of deformity, having all the characteristics of genu valgum, due to a fracture at the lower end of the femur, is reported by Mollière.[2] It was corrected by refracture by Robin's osteoclast.

It is evident then that genu valgum can not be explained on any one theory, but that many causes combine to produce it, and that the deformity is due to changes in the bones forming the knee joint.

That true genu valgum is capable of a *spontaneous* cure—that is, without any treatment—is doubtful. From the nature of the deformity it is difficult to understand what reparative or corrective force could act so as to obliterate the abnormal curvature of the bone or change the relation of the condyles when the deformity is due entirely to differences in their plane. Macewen,[3] in speaking of spontaneous cures, says that "there can be no doubt that cases have occurred during childhood when the deformity, though at one time marked, has undergone rectification without

[1] "Orthopædic Surgery," 1868, p. 192.
[2] "Lyon méd.," December 23, 1883, p. 549.
[3] "Osteotomy," p. 92.

operative interference," yet in the following line mentions the necessity for some kind of treatment.

It is true that limbs affected with this deformity have been reported as having become straight in later years without any treatment whatever, and that children have "outgrown" it. But the details of such cases have been so meager as to raise a reasonable doubt as to the nature of the deformity. No case has fallen under my own observation, nor have I been able to satisfy myself that they have occurred.

Symptoms.—A person with genu valgum to any marked degree walks with difficulty, is easily fatigued, and locomotion is often painful and almost impossible. In infancy and early childhood these patients are often able to get about, but with frequent falls. Later they seem to acquire the habit of balancing themselves better, and walk and even run, but awkwardly. In later years locomotion often becomes again difficult and painful, so that crutches have to be used.

The more relaxed the ligaments the greater is the difficulty in getting about. The deformity may be so great that the knees are crossed in standing. Genu valgum may affect both limbs or only one. If the former case, it is generally more marked on one side than on the other.

In marked cases the patella is dislocated outward, and is found riding over the external condyle, being forced into this position by the change in the axis of the tibia, or it may slip during flexion to the outside of the condyle. I have met with several cases of the deformity in adults complicated with effusion into the joint, accompanied with considerable

pain. Loose bodies are found in rare cases in the cavity of the joints in those well advanced in years, but these may have had no connection with the deformity. The shape of the foot varies in knock-knee. Macewen[1] states that the foot is well arched, the instep high, and the patient walking principally on its outside. When the foot is nude and the patient walks, the extensor and the flexor muscles are seen to be brought well into action, and the toes seem to grasp the floor in endeavoring to maintain the equilibrium. I do no think that this statement is strictly correct. I have seen advanced cases in which the arch of the foot was flattened, although the child was walking about. And in one of the patients with genu valgum adolescentium there was marked dropping of the arch. In many, however, the condition mentioned by Macewen is found to exist. Knock-knee is often, in rachitic subjects, complicated with other curves of the long bones, as in Fig. 20, taken from a photograph of a patient at present under treatment.

Mikulicz[2] has recorded the result of some post-mortem examinations of limbs affected with genu valgum. He found that there had been an increase of that portion of the diaphysis of the femur over the internal condyle, placing it on a lower plane than the external.

Contraction of the biceps is seen in some cases of long standing. It is not a primary condition. It is due to the patient attempting to stiffen the knee joint in walking and standing. In advanced cases there may be some flexion of the leg on the thigh,

[1] *Loc. cit.*, p. 34.

[2] "Archiv. klin. Chirurg.," vol. xxiv, 1879, p. 192.

and secondary contraction of the fascia on the outer aspect of the limb. These may also exert some rotation of the tibia outward.

The treatment of knock-knee is mechanical and operative.

1. *Mechanical Treatment.*—That genu valgum can be cured by the use of splints in both infantile and adolescent cases is a question concerning which there

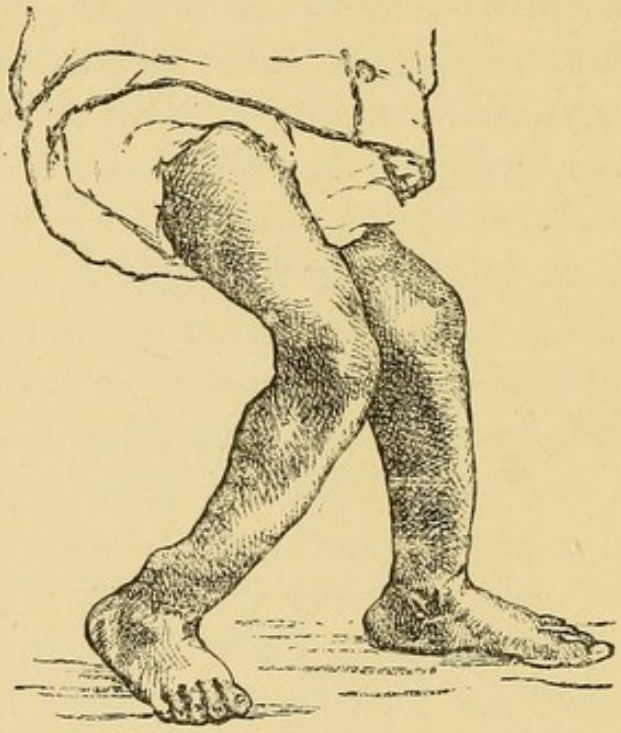


Fig. 20.

is no doubt, if they are placed under proper treatment during the early stage of the disease—that is, before the bones have become hardened and the epiphyses fixed to the diaphyses. The period during which we may reasonably expect to correct the deformity depends upon the general health of the patient and the rapidity with which the earth-salts are deposited in the bone-cells. It should be remembered that the

degree of softening sometimes varies in different bones of the same individual, so that one limb may be straightened by braces while in the other they are useless. Braces for the correction of this deformity should extend from the trochanter to the external malleolus. They should permit of no flexion of the leg on the thigh, and they should be of sufficient strength to exert a continuous force on the bones of the limb in a direction from within outward. The power may be applied either with a bandage or leather straps. A simple well padded wooden splint may be used, to which the whole limb is firmly bandaged, or a steel instrument may be applied. The patient should not be allowed to walk more than is necessary.

The object aimed at in the treatment of genu valgum by orthopædic appliances is to so act on the femur that the leg will be thrown directly inward. If the femur is still pliable, and the external lateral ligament strong, this bone will be thrown outward at the lower third and the depressed condyle raised. If, however, the external lateral ligament is relaxed or weakened, the tibia will be drawn into a straight line with the long axis of the femur, but no change will take place in the femoral curve. The external ligament will allow the tibia to be swung inward on the internal condyle as a center, leaving a space between the external condyle and the outer head of the tibia, and thus no direct force can be applied to the femoral curve.

I am satisfied that this is one cause of the want of success in the mechanical treatment of infantile knock-knee. In such a case, if the tibia be held in

its normal position, and the patient allowed to go about, the weight of the body will fall upon the internal condyle, and, provided the bone is still soft, it may yield and the deformity be permanently corrected. It is evident that in cases where the external, lateral, and, of course, the crucial, ligaments are weak, care should be taken that but slight traction be made upon these tissues by much force being applied to the tibia. A relaxed lateral ligament is as much of a hindrance to walking as a valgoid knee with unrelaxed ligaments. Dr. N. M. Shaffer thinks that, in cases due to increased growth of the internal condyle, by relieving the external condyle from pressure it takes on a more rapid growth, and thus fills up the interval between the external portion of the femur and tibia. At an early stage of rickets, thus transferring the weight from the external to the internal condyle may cause the latter to become flattened, or even atrophied.

In adolescent cases the time of increase of the deformity is the only period during which we may hope for any change in the limb by mechanical means, and it should be the time of active treatment, as the new soft bony tissue soon becomes dense and hard, the epiphysis becomes united to the diaphysis, and correction is not possible.

In proof of the statement that the mechanical treatment of genu valgum is far from satisfactory, we would refer to the statistics of a well-known orthopædic dispensary in this city, at which patients receive the best of care and attention, and where they are placed, as far as the mechanical management of the case is concerned, under the most approved meth-

ods. From 1876 to 1883 there were treated 99 cases of knock-knee. Of this number only 13 were over five years; 17 were discharged cured; 48 relieved; 8 discharged for neglect; and 29 were still under treatment, making about 23 per cent of cures. In arriving at these figures, we have looked upon the 48 discharged relieved as though they had been dismissed unrelieved. Or, looking at these cases in the most favorable light — that is, deducting the 13 patients over five years of age as being incurable— we find that out of 60 cases 17 were cured; not quite 30 per cent.

The simpler the mechanical support the better. I have seen a perfect result from the use of a simple straight wooden splint in a girl three years of age, in whom the bones were very pliable.

No rule can be laid down as to the age beyond which mechanical treatment will fail from the hardening of the bones. I think, however, that the amount of spring there is in the tibia is something of a guide. If one grasps the leg just above the ankle with one hand, and below the knee with the other hand, and attempts to bend the bone in a healthy child of two or three years of age, it will be found that it will not yield with the use of any force that can be borne. In a rickety child, with soft bones, the tibia will be felt to yield, even up to the fifth or sixth year, provided the disease has not been arrested, and it would seem that this test is something of an index as to the hardness of the bone. At all events, I think that when one can spring the bone, a trial of braces should be made.

If no improvement is obtained after a few months'

treatment with braces properly applied and cared for, they are of no use, and further mechanical treatment is worse than useless, for, if braces do no good, they do harm by being a useless incumbrance. As stated before, a patient with relaxed ligaments is the most unfavorable subject for any kind of treatment, but especially mechanical.

2. *Operative Treatment.*—Section of muscles and ligaments has been practiced for the cure of genu valgum, but with no success. Bonnet, who first advocated and performed section of the tendon of the biceps, states that "in no instance was it followed by success." It has been performed by other surgeons, but with no better results. The danger of section of the popliteal nerve should not be forgotten. Division of the external lateral ligament, together with the tendon of the biceps, has had many advocates. It has been practiced by Langenbeck, Billroth, and others. Section of the ligament is always followed by lateral movement of the knee joint, and can not be an aid in rectifying the deformity.

Mr. Broadhurst, who still is an advocate of the operation, exhibited, at a meeting of the Clinical Society,[1] a patient on whom he had made a section of the tendon of the biceps and the external ligament of the knee joint five months previously. The patient was unable to walk without a splint, and there was much lateral motion at the knee joint.

Mr. Barwell, in some remarks on the operative treatment of this deformity, states that a section of these structures is worse than useless. Inflammation of the knee joint has been known to follow such an

[1] "Brit. Med. Jour.," June 14, 1879, p. 897.

operation. I had this happen in a case in which I foolishly divided these structures, and ended in the death of the patient. *Redressement forcé*, as advocated by M. X. Delore, as well as osteoclasis, will be referred to in another chapter.

Partial excision of the knee joint has been performed by Mr. Annandale,[1] resulting in a stiff knee, and by Mr. Howes for genu valgum due to atrophy of the internal condyle.[2]

[1] "Edinb. Med. Jour.," July, 1875, p. 18.
[2] "Guy's Hosp. Report," 1875, p. 531.

CHAPTER V.

OSTEOTOMY FOR GENU VALGUM.

The earliest operation for the relief of genu valgum of which there is any record was performed by Mayer, of Würzburg, in 1851. He made a cuneiform osteotomy of both tibiæ, through an open wound, with a saw. In one limb the line of incision healed upon the sixth day, and firm, bony union was established on the twenty-fourth day. He then operated upon the other limb. He accidentally divided the posterior tibial artery and vein, and the patient died of tetanus on the sixty-second day. He operated upon two other patients with good results. Billroth,[1] in 1873, divided both the tibia and fibula for the relief of knock-knee. Mr. Annandale[2] excised the lower end of the femur in a case of marked knock-knee. The patient was cured with an anchylosed joint. Schede[3] removed a wedge-shaped piece from the tibia, and divided the fibula with a chisel in a case of genu valgum with success. Ogston, in 1876, separated the internal condyle from the femur, and, sliding it up, brought the two condyles on the same plane. Since then several operations have been devised to accomplish the same end, which may

[1] Langenbeck's "Arch.," 1875.

[2] "Edinb. Med Jour.," 1875, p. 18.

[3] "Lond. Med. Rec.," June 15, 1877, p. 246.

be classed under two heads: Operations upon the condyle, and operations upon the shaft of the femur or tibia.

1. OPERATIONS UPON THE CONDYLE.

Ogston's operation was to separate the internal condyle from the shaft, and then to slide it up until the two condyles were upon the same plane, and thus swing the tibia inward. The following is his method of performing the operation: After the patient is well under the influence of an anæsthetic, and the limb rendered bloodless, the leg is flexed on the thigh as far as possible, and the femur rotated outward. A long tenotomy-knife is introduced three and a half inches above the tip of the internal condyle, on the inner side of the thigh, and so far back as to be opposite the ridge running between the linea-aspera and the condyle. Its blade is then carried forward, downward, and outward over the front of the femur, with its cutting-edge directed to the bone, when its point can be felt under the skin in the groove between the condyles, where the patella would normally have been lying in the extended position of the limb, the cutting-edge is pressed against the bone, and the soft parts divided with a slow movement in withdrawing the knife. The external wound thus made should be about one third of an inch long, and form the entrance to a subcutaneous tunnel running obliquely over the front of the femur and ending in the cavity of the joint. An Adams's saw is then introduced into the tunnel, and the condyle sawn off by directing the edge of the instrument straight backward. When it is estimated that the

edge of the saw has arrived near the popliteal space it is withdrawn, the knee completely extended, and with the hands, and the operator's knee as a fulcrum, the patient's knee is then forcibly straightened by bending the leg inward, the remaining connections of the condyle with the femur giving way with a crack on the application of very moderate force, and instantly the leg becomes straight. The whole operation is done under strict antiseptic rules (Lister), and the limb put up in splints in a corrected position. Fig. 21 represents the line of Ogston's section.

Reeves[1] modified Ogston's operation by making the section with an osteotome in the following manner:

A scalpel, previously dipped in carbolized oil, is introduced obliquely just above the tubercle for the attachment of the tendon of the adductor magnus, and the soft parts and periosteum are divided in the line of the Ogston's section, the length of the wound in the soft parts being long enough to easily admit the osteotome. This instrument is then introduced, and, commencing on the ridge of bone going from the tubercle for the attachment of the tendon of the adductor magnus to the linea aspera, is driven downward and outward toward the inter-condyloid notch; the bone being *divided only as far as the cartilage on*

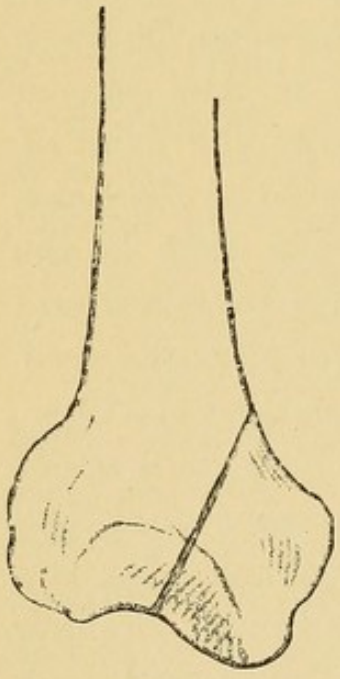


FIG. 21.

[1] "Brit. Med. Jour.," May 25, 1878.

its articular surface. The condyle is then loosened by using the chisel as a lever, and is separated completely by forcibly straightening the limb, which is at once put up in a permanent dressing. Fig. 22 shows the extent of the cut in the bone in Reeves's operation. He claims that by this method the joint is not entered either by the chisel or in forcibly sliding the condyle up, the cartilage being bent to accommodate itself to the new position of the condyle. It may be possible in a few cases to prevent the osteotome from entering the joint, but, in sliding the condyle up, the cartilage is lacerated and the joint thus opened.

Another operation, having in view the raising of the plane of the internal condyle, is described in the "Edinburgh Medical Journal," 1879, p. 881, by Mr. Chiene, as follows: "Find the tubercle on the internal condyle to which the long tendon of the adductor magnus is attached. An incision two or three inches in length is made over the tubercle in the long axis of the limb; the incision commences half an inch below the tubercle, and is carried upward for a sufficient distance. After the division of the skin and the fascia, the tendon of the adductor magnus is exposed. Pass in front of the tendon, between it and the fibers of the vastus internus. The bone covered by periosteum is exposed, and the superior-articular artery is seen and

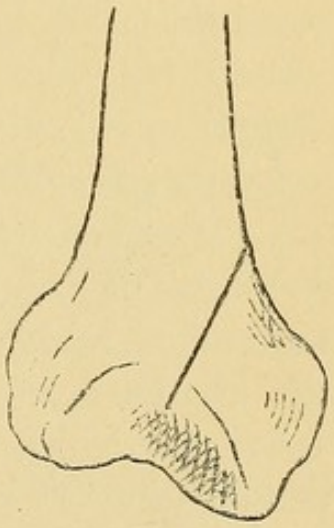


FIG. 22.

divided, after passing a double ligature below it and tying the vessel. The periosteum is then crucially incised and turned aside, exposing the bone. With a chisel and mallet a wedge-shaped portion of bone is removed from the base of the condyle, immediately above the tubercle of attachment of the adductor magnus. The breadth of the wedge will depend on the amount of the deformity. The long axis of the wedge runs downward and outward toward the notch between the condyles. The wedge is at a higher level than the epiphyseal line." He

FIG. 23.

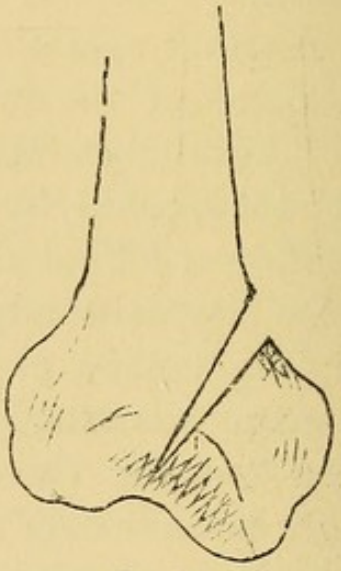


FIG. 24.

then bends the lower portion so as to displace the condyle upward. Fig. 23 shows the extent and position of the wedge removed in Chiene's operation.

Macewen performed an operation somewhat similar to that of Chiene, except that he removed the wedge in Ogston's line, and then, folding up as it were the internal condyle, corrected the deformity. Fig. 24 represents Macewen's first operation.

Schmitz,[1] of St. Petersburg, performed an Ogston's operation through a large wound, claiming as an advantage that he could see what he was doing.

All of these operations have one thing in common, namely, operating upon the internal condyle. Ogston's seems the most dangerous, on theoretical grounds, in that the joint is directly opened, yet inflammation has rarely followed it, and out of the number operated upon failures have been very few, and a fatal issue has been exceptional. In most of the cases there has been effusion of blood into the joint. A case of suppuration has been reported, but the pus was outside of the joint. There has been one case of ankylosis at a right angle, but neither necrosis nor inflammation of the bone has ever been reported. The object aimed at by either an Ogston's or Reeves's operation is to separate the internal condyle from the shaft, and then to slide it up so that its lower surface shall occupy a higher plane, and thus carry the long axis of the tibia inward and correct the deformity. In neither of these operations are the ligaments divided or weakened. In some few cases over-correction has been made, and a genu varum has resulted. In Reeves's operation the joint is certainly not entered by the chisel in some cases, although it is broken into in all. On anatomical grounds, these operations are correct in those cases in which the defect lies entirely in the internal condyle. After correcting the deformity there remains a re-entering angle on the lower surface of the articular end of the femur. This in time is filled up partly by osseous material and

[1] "Centralblatt f. Chir.," April, 1879.

partly by connective tissue derived from the serous surface of the condyle (Thiersch).

An objection was raised by Thiersch, at the seventh congress of German surgeons, held in 1878, to Ogston's operation for genu valgum, in that he feared the interruption of the epiphyseal cartilage might easily interfere with the growth of that portion of the bone.[1] I am not aware of any case in which this result has been reported. Recently, through the kindness of my friend, Dr. F. Lange, I have had the opportunity to examine a case in which atrophy or arrest of development has occurred after an Ogston's operation. The patient is a healthy-looking girl, eight years of age, on whom, in 1878, when two years old, an Ogston's operation was performed for unilateral genu valgum of the left limb. For two years nothing abnormal was noticed, but at the end of that date the left knee began to bend outward, and walking became difficult.

This outward displacement continued to increase, and with it the embarrassment in getting about. There has been no pain about the knee joint. On examination, there is found to exist a marked genu varum on the left side when the leg is extended which disappears on flexion. The joint looks broader than the right, and measures one inch more in circumference than the other. The anterior surface of the external condyle is prominent, owing to a displacement of the patella inward. The internal condyle is much smaller than the corresponding one of the right limb, and its lower border is on a plane an inch higher than that of the external, and

[1] "London Med. Record," June 15, 1878, p. 269.

there is a corresponding loss of substance on the inner side of the femur, in the location where the internal condyle should be in the normal limb; its anterior aspect is also more posterior. It is felt as an oblong excrescence on the shaft of the bone, and is much smaller in all its diameters than the one in the corresponding limb. It evidently has not kept pace in its growth with the rest of the bone, if indeed it has grown at all. The space left by the change in the plane of the condyle is occupied in front by the patella, which is dislocated inward and does not leave its abnormal position in any motion of the leg. The inner head of the tibia has increased in height more than its external, so that it partially occupies, in the extended position, the gap left at the lower end of the femur. The operation-wound is represented by a slight cicatrix. The increase in the circumference of the knee is due to the displacement of the patella.

From this description it is evident that the operation, by cutting through the epiphyseal cartilage, has seriously interfered, if it has not entirely arrested, the growth of the internal condyle, and has left the patient in a much worse condition than if the operation had not been performed. This case exhibits a fatal defect in Ogston's operation upon patients who have not attained their full growth. And the same remark is applicable to all operations upon the condyle that in any way interferes with the epiphyseal cartilage.

'Reeves's is a difficult operation to perform. The section has to be made slowly, and you are near important vessels. If the ligaments are relaxed or

weakened so that they stretch, it is very difficult to slide the partially detached condyle up. In two cases I failed to correct the deformity from this cause. It, however, has this advantage: that recoveries are much more rapid than after any other operation.

Both Macewen's and Chiene's cuneiform osteotomies at the internal condyle were successful. They are difficult operations to perform, and they have the disadvantage of being done through an open wound. They have not been repeated by any other operators.

2. OPERATIONS ON THE SHAFT.

In 1877, Macewen corrected a case of genu valgum by making a transverse section of the shaft of the femur from the inside, a short distance above the epiphyseal line of that bone, in the following manner: After rendering the limb bloodless, with a sharp-pointed knife an incision was made at a point where the two following lines meet—one drawn transversely a finger's breadth above the superior tip of the external condyle, and a longitudinal one drawn half an inch in front of the adductor-magnus tendon. This line of division is above the epiphyseal cartilage. Fig. 25 shows the line of section in Macewen's second operation.

Mr. Barwell, acting upon the theory that knock-knee is a deformity due always to changes in the femur and tibia, makes a section above the epiphyseal line of the femur, and corrects one half of the deformity. Two weeks later he divides the tibia and fibula near the knee joint and corrects the other half,

thus performing three osteotomies. He certainly obtains no better results than Macewen does by a single section. In some cases, however, of very marked genu valgum, a femoral section does not correct enough, and then a section of the tibia should be done; but, as a rule, there is no necessity of performing more than one osteotomy, and when there is no necessity it is worse than useless.

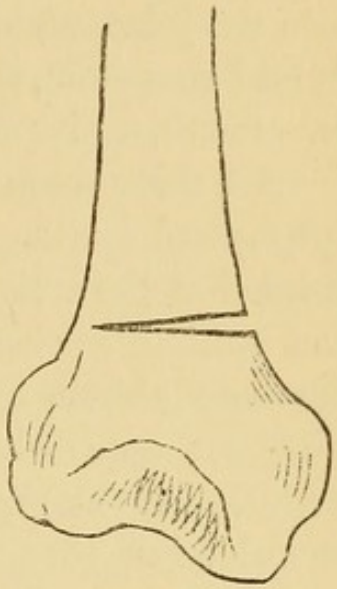


FIG. 25.

MacCormac[1] advocates section from the outside, making the division just above and parallel to the articular surface. He penetrates the bone to three fourths of its thickness and then fractures. Dr. E. H. Bradford, of Boston, has repeated MacCormac's operation, and speaks well of it.[2]

Taylor[3] divided the shaft of the femur from the outside a hand's breadth above the joint. This operation is evidently only applicable to cases of genu valgum due to femoral curves.

Reeves[4] advocates the division of the femur just below its middle, and states that he has performed this operation seven times. He calls it mid-femoral osteotomy. Its advantages, he thinks, are: First, the bone is divided nearly at its smallest part; therefore, Second, the operation is more quickly done.

[1] "Antiseptic Surgery," p. 189.

[2] "New York Med. Jour.," January, 1881, p. 26.

[3] "Brit. Med. Jour.," April 7, 1877, p. 429.

[4] "Brit. Med. Jour.," December 10, 1881, p. 935.

Third, the deformity is readily corrected, and the large callus which forms when supra-condyloid osteotomy is performed is avoided. Fourth, the effusion into the joint, which sometimes follows the supra-condyloid operation, is avoided. Fifth, recovery is quicker. Sixth, multiple osteotomies are done away with.

All these operations upon the shaft are above the epiphyseal cartilage, and at such a distance from the joint that the articulation is not entered by the chisel, and seldom fractured into in straightening the limb. Sections above Macewen's line are seldom made. They are applicable only to those cases of genu valgum due to femoral curves, and even in this class it is not often that the deformity is due to this cause alone, overgrowth of the bone just above the internal condyle, or changes in the condyle itself, being superadded. Division just above the epiphysis is applicable to all cases of knock-knee dependent on femoral changes, whether the section is made from within outward (Macewen), or from without inward (MacCormac). It is true that in the former the limb is slightly shortened, while in the latter it is lengthened, but the difference is too little to be taken into account, provided the same operation is performed on both limbs. Reeves's objection to the supra-condyloid operation, in that the joint is at times affected, I think of little moment. Effusion into the articulation is very seldom seen, and, when it does exist, is soon absorbed. Mid-femoral operations are applicable to but few cases. The presence of a large callus is exceptional in my experience, and the time necessary for firm bony union to take place is the same in both cases.

But few operators have adopted either Taylor's or Reeves's mid-femoral line of section. The majority make the division just above the epiphysis.

Of the operations for the correction of genu valgum, that devised by Macewen has superseded all others. It is easier to perform, is applicable to all cases, is so far removed from the joint that there is no danger of injury to it or its ligaments, and at the same time is near, if not directly, at the point of abnormal deviation.

I have had experience with but one other, and that is Reeves's section in Ogston's line.

Macewen's supra-condyloid operation may be performed in the following manner: The patient having been etherized, an Esmarch's bandage is applied, extending well up on the thigh so as to be entirely out of the way during the operation. The leg is fully flexed on the femur, the thigh rotated outward, so as to give easy access to its inner portion just above the knee joint, and the limb is laid on a sand pillow, which has been molded to the knee and lower portion of the thigh, so as to give a firm bed for its support during the operation.

An incision is then made down on the ridge of bone running from the tubercle for the attachment of the tendon of the adductor magnus to the linea aspera, at a point a finger's breadth above a line drawn inward from the lip of the external condyle. The incision should be made parallel to the long axis of the limb, and a little longer than the width of the largest instrument. Keeping the knife in position, the largest osteotome is then passed down on it as a guide, and, when on the ridge of

bone, the knife is withdrawn and the instrument rotated so that the cutting-edge is at right angles to the line of incision. It is better to begin the section from this point, directing the osteotome outward and forward, for by so doing the inner and posterior-lateral portions of the femur are divided first, and you are working away from the vessels. After the compact tissue of the femur has been divided, the progress of the osteotome through the central portion of the bone will be more rapid until the external shell is reached. This will be readily known by the greater resistance offered to the instrument. If the osteotome becomes wedged, it should be replaced with the next smaller. After the bone has been divided on its inner anterior and posterior aspect, and the instrument has penetrated into the compact bony tissue on the external aspect of the femur, the osteotome is withdrawn and the leg extended on the thigh, the wound having been covered with a sponge wet with carbolized water. Then grasping the lower portion of the femur just above the point of section with one hand, and the leg with the other, using the latter as a lever, the remaining portion of the femur is fractured. The wound should be treated in the manner mentioned on page 22. After placing a compress over the wound, the whole limb, from the toes as far up on the thigh as possible, is bandaged with a flannel roller, and over this plaster-of-Paris bandages placed. Before the latter sets, the leg is to be carried inward, so as to bring it a little beyond the long axis of the femur; or, in other words, to overcorrect the deformity. Care should be taken to keep the leg well extended on the thigh while the plaster

is hardening. In order to keep the limb in position while the plaster is drying, it is an advantage to place a roll of flannel, about four inches in diameter covered with rubber cloth, between the thighs above the point of fracture, and, using it as a fulcrum, to bend the two legs together and tie them. The feet should rest on a pillow, in order that the knees do not become flexed. Care should be taken that the two fragments are in such a position that there may be no lateral displacement. In one case I have seen a sliding backward of the lower fragment, but not enough to cause any trouble, yet it is well to avoid this. After the splint has well hardened, the patient is returned to the bed and the limbs suspended by passing a bandage under the middle of the leg and over the bed cradle, or any suitable apparatus that may be at hand can be used. Suspension seems to give comfort. On the third day the wound is examined, the splint is left on for four weeks, when it is removed and the patient allowed to use his limbs, and, if the union seems firm, to go about.

The operation described above varies from that of Macewen in three particulars: 1st. In the omission of Listerism; 2d. In the position of the limb during the operation; and, 3d. In the method of treating the wound. The reasons for the first and third variations have been given when describing the operation of osteotomy, page 24. The reasons for the second are as follows: Macewen operates with the limb fully extended[1] and rotated outward, and makes his incision where the two following lines bisect one another—a line drawn transversely a finger's breadth

[1] "Lancet," December 28, 1878, p. 911.

above the level of the upper border of the external condyle, and a line drawn parallel to and half an inch in front of the tendon of the adductor magnus. This line, Macewen states, is below and anterior to the anastomatica magna, and above the superior articular.

It is much easier to get at the inner aspect of the thigh with the leg flexed than when it is extended. The ridge of bone running from the tubercle for the attachment of the tendon of the adductor magnus to the linea aspera is a much more certain guide than a line half an inch in front of that tendon. This ridge is very easy to find, and, with the leg flexed, there is no difficulty in cutting down upon it. Another advantage in operating with the knee bent is that when the leg is extended the skin and subcutaneous tissue slides downward and forward, and thus closes over the wound in the muscles. I think also that a firmer support for the limb is obtained when the leg is flexed.

G. C. Wright,[1] surgeon to the General Hospital for Sick Children, Manchester, makes a section with a saw from outside, on a line above the adductor tubercle.

CASES APPROPRIATE FOR OSTEOTOMY.

Infantile Cases.—These may be considered under two classes—those in which the bones have become hardened, and those in which the process of sclerosis is still going on.

I. There can be no doubt as to the necessity of an osteotomy to correct a genu valgum after the

[1] "Abstracts of Medical and Surgical Cases treated at the General Hospital for Sick Children," Manchester, 1882.

bones have become hard. The question as to the date at which this condition has been reached is much more difficult to answer; and, as said before, it is not a question of age, but of *nutrition*. Thus, I lately performed an osteotomy for unilateral knock-knee on a child three years of age. She had been under good mechanical treatment for six months without the slightest effect on the deformity. In making the section, the femur was found to be very hard and very difficult to divide. Again, on doing a supra-condyloid operation on a boy eight years of age, the bones were quite soft. If the deformity had been uncomplicated, I have no doubt it could have been corrected with splints. I do not see how any fixed rule can be laid down as to the age at which an osteotomy should or should not be performed. It would seem, however, that if, after several months of careful mechanical treatment, there has been no improvement, any further use of braces is worse than useless, for if they do no good, they are certain to do harm. They cause atrophy of the limb, are a hindrance to locomotion, and a constant cause of care and expense.

In regard to the condition of the bone, the state of the tibia has seemed to be something of a guide.

If by the use of moderate force (and by moderate is meant *not* enough to cause any pain) the bone is felt to yield or spring, it is safe to conclude that the bone has not become hard. It is, however, to be remembered that the intensity of the rachitic process falls upon different bones in different degrees, and that the condensation process is often very much further advanced in one bone than in another in

the same individual. If the bone does not yield, the sclerosis has advanced so far that mechanical treatment will fail as a rule.

There is another condition which complicates both mechanical and operative treatment, but the former more than the latter, and that is a relaxation of the ligaments. A child with weak, but not relaxed, ligaments is not a good subject for mechanical treatment. In healthy children braces will fail to correct a case of genu valgum after the fourth or fifth year. I think that the practice of compelling children to wear mechanical appliances for the relief of knock-knee for years is cruel, and should be condemned. By early recognizing which cases are appropriate for mechanical treatment and those which are not, much time can be saved. I think that a relaxed ligament is an argument in favor of an early operation.

II. Those cases in which the bones have become only partially sclerosed.

Some of these cases, perhaps the majority, occurring in children at or about the fourth year can be corrected by mechanical appliances, if the external lateral ligament is strong. Yet in practice it is not often accomplished. The vast majority of cases of knock-knee are children of the poorer classes, among whom it is almost impossible to have an instrument properly applied and cared for. They have not the time, and often not the intelligence, to give their children proper attention. In proof of this, reference is again made to the statistics given on page 90. Out of fifty-seven children under five years of age affected with knock-knee, only thirteen were discharged cured,

and this at a dispensary distinguished for the care and attention given to its patients. It is a question, therefore, whether the majority of children in good health, over four years of age, would not be enabled to walk sooner by an operation, and whether more children would not be permanently cured in early life by this means than by being submitted to mechanical treatment? I must confess that my own feelings are decidedly in favor of an operation.

Properly performed, osteotomy is not a serious operation. It is not only justifiable, but is for the best interests of this class of patients. In knock-knee occurring among the better classes, I think that a fair trial of splints should be made in healthy-looking children under four or five years of age. If they fail, an osteotomy should be done.

In cases of genu valgum adolescentium the same rules apply in regard to their management as in the deformity occurring in children. It can be corrected by apparatus before the bone has become consolidated. After that by an osteotomy. The deformity is of rapid formation, and the bone soon becomes hard, so that mechanical treatment, to be efficacious, must be begun early.

The result on the bone at the point of division is to cause a condensation of the osseous structure on either side of the osteotome, and thus form a wedge-shaped cut into that tissue. Dr. A. T. Cabot[1] has recorded the post-mortem appearance of the bone at the point of section after a Macewen operation (Plate V), the patient dying, six weeks after section, of typhoid fever. He says: "In this figure the inner side of the bone

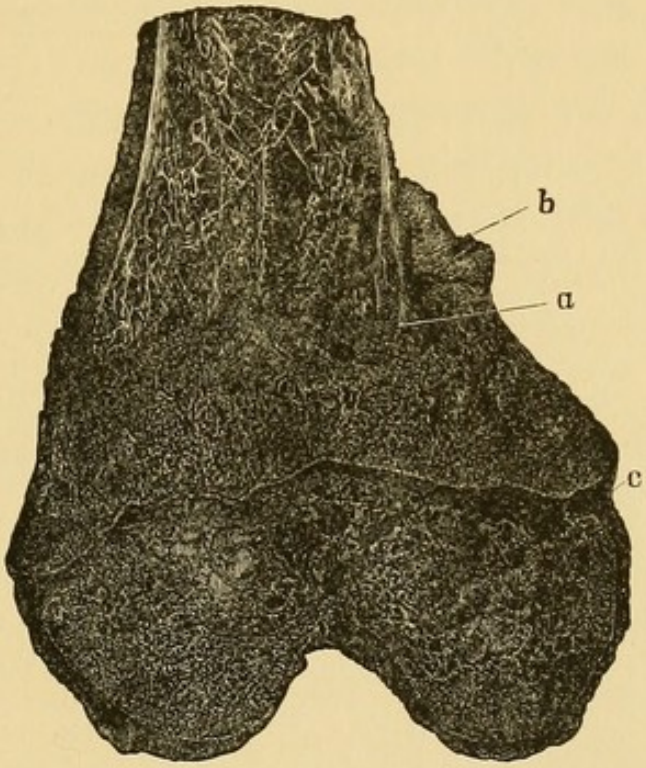
[1] "Boston Med. and Surg. Jour.," February 16, 1883, p. 154.

upon which the chisel was entered is to the right. At *c* we have the line of the epiphysis; three fourths of an inch above this is the line of division. On the outer side of the bone the line of the shaft is pretty well preserved. On the inner side a considerable displacement has occurred. The compact wall of the shaft has been driven down into the cancellated tissue at the point *a*. The tissue in the middle of the shaft, on the other hand, was less resistant than the more densely cancellated tissue below, so that the center of the lower fragment is impacted into the upper. A very firm locking is the consequence, and this, no doubt, greatly facilitated rapid recovery. That there has been but slight reaction in the parts above is shown by the absence of callus. The only true callus formation is seen at *b*, where a little new bone has been thrown out over the free end of the lower fragment; besides this there is only a very thin layer of new bone under the periosteum on the outer side."[1]

Results.—As to the limb. The object of a subcondyloid (Macewen's) operation is to make a wedge-shaped incision into the lower end of the femur, just above the epiphysis, extending from within outward, the apex of the wedge penetrating the compact osseous structure on the outer aspect of the bone. By the use of the largest osteotome at the beginning, and only replacing it with the next smaller when it is absolutely necessary, on account of the instrument becoming wedged, the cut in the bone is made wider, not by any loss of substance, but by condensation of the bone on either side the instrument. In cases of

[1] "Boston Med. and Surg. Jour.," 1882, vol. cvi, p. 155.

PLATE V.



Dr. A. T. Cabot's case—the parts after a supra-condyloid operation.

knock-knee where the deformity is not very great, in bending the leg inward the two opposite surfaces of this V-shaped cut come into apposition, and just correct the malposition of the leg. No re-entering angle is left on the outer aspect of the femur. If, however, the deformity is great, there will exist a re-entering angle opposite the point of section on the external aspect of the bone. This, as has been proved by post-mortem examination, will fill up with new bone, the same as after a simple fracture. The effect on the bone, as a whole, is to compensate for the curve with its convexity inward, by a sharp bend having its angle at the lower end of the bone. In

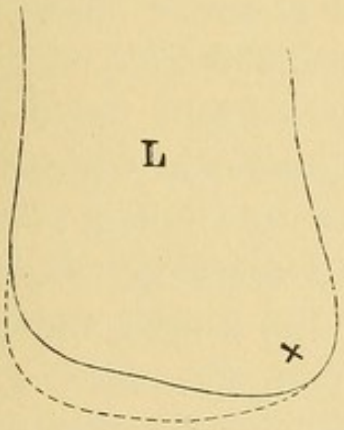


Fig. 26.

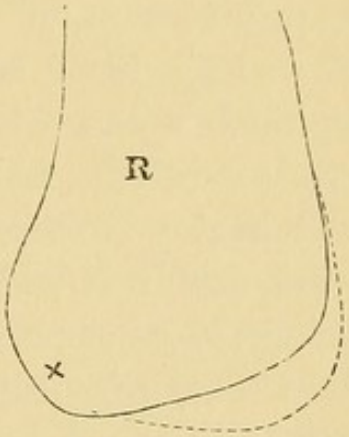


Fig. 27.

those cases where the deformity is due to a change in the shape of the condyle, where it is depressed either by growth or by the abnormal deposit of bone just above it, the result of the operation is practically to remove a wedge-shaped piece of bone, and thus raise the plane of the condyle. That there is an actual change in the plane of the two condyles after a supra-condyloid operation is demonstrated in Figs. 26 and 27. They are reduced from tracings of the

lower end of the femur before and after the operation. The cut marked R is from the right, that marked L from the left limb; the star indicates the internal condyle, the heavy line the contour of the parts before, the dotted line after the section. It will be noticed that the two condyles after the operation are upon the same plane. The distance between the two lines is the amount of correction gained by the operation. It is true that the correction in some cases is not at the real point of deformity, yet practically it is perfect as far as the position of the tibia is concerned, and this is the real deformity.

Suppuration.—In a carefully performed osteotomy, suppuration of any amount is rarely met. In my own experience, after a supra-condyloid operation, suppuration has occurred in four limbs only. In three it evidently had its starting-point in a piece of tissue that protruded from between the lips of the wound, and was irritated by the dressing. On removing the compress from over the wound, the pus flowed out, proving that the pad, hardened with blood, prevented its escape. The application of a large compress in the course of the abscess was soon followed by a cure. The other abscess I can assign no cause for. It was small, and gave no trouble. In two of these cases the thermometer gave no indication of the presence of matter, the temperature being normal the whole time.

STATISTICS.

Of six hundred and twenty-two cases of Macewen's operations (section above the condyles), as

far as can be ascertained, there have been but three fatal cases reported that could in any way be attributed to the operation. One was a case reported by Dunlap, where death was due to septicæmia secondary to a cellulitis of the thigh due to improper dressing; one, by Bull, was probably the result of carbolic-acid poisoning. Langton[1] reports a case in which he performed a Macewen's operation on the right femur of a patient nineteen years of age. Not much bleeding occurred at the time of the operation, but in the evening the dressings (Lister) were filled with blood; they were removed for the same cause daily during the next four days, and then a drainage-tube inserted. Ten days later the patient lost six ounces of blood; as the hæmorrhage continued, the wound was enlarged. The end of the lower fragment was found posteriorly, and from it projected a sharp spicula of bone. The ends of the fragments were excised and the popliteal artery exposed. It was then found that there was a small hole on its anterior aspect of the size of the splinter of bone. The artery was ligated above and below the point of puncture. The next day the leg became gangrenous, and an amputation was performed two inches above the end of the upper fragment. The patient died the same evening. McGill[2] reports a case in which, during a supra-condyloid operation, the popliteal artery was completely divided transversely, the vessel was exposed, and both ends ligated with antiseptic catgut. The patient made a good recovery, the deformity being relieved.

[1] "Lancet," March 29, 1884, p. 564.

[2] "Lancet," May 17, 1884, p. 891.

In two cases the anastomotica magna has been divided during a Macewen's operation—once by Gerster[1] and once by Marsh.[2] In both of these cases the point of the incision in the skin was determined by Macewen's rule, and the limb was operated upon with the leg in an extended position.

There have been other deaths reported, viz.: from diphtheria, meningitis, pneumonia, and uræmia; but they should not be attributed to the operation. It is claimed by Macewen, and I think justly, that Dunlap's operation was not a strictly supra-condyloid section according to his method. It was performed with a chisel, and not an osteotome, "and the line of the section was zigzag."[3] But as the fatal issue was not due to anything about the wound, but to an error in dressing, even this case should not be charged to the operation. Bull's case of carbolic-acid poisoning is excluded on the same ground. There has, therefore, been but one death recorded from the operation.

In thirty cases the section was made from the outside. In twenty-seven of these the bone was divided with a saw; in the other cases an osteotome was used. In eleven cases section was made with a saw in Macewen's line. In none of these did suppuration occur. There have been ten cases recorded in which suppuration has occurred after a supra-condyloid operation, and in none of these did the pus communicate with the bone. There have no doubt been many other cases in which it has occurred, but no record has been made of the fact.

[1] "N. Y. Med. Jour.," February 23, 1884, p. 227.
[2] "Brit. Med. Jour.," April 5, 1884, p. 665. [3] Private note.

In one case (Taylor[1]) there was some effusion into the joint a day or two after the operation. Weir also reported a case where this took place some weeks after the operation, when the patient began to use this limb. In the latter case it is probable that the effusion was due to over-exercise. In two cases considerable stiffness persisted for some time (Wright,[2] Rabagliati[3]). In one case the deformity returned, and Ogston's operation was performed with a good result. In this case the section was made from the outside; the patient may possibly have been permitted to go about before the new bony deposit had become well consolidated, and the deformity thus reproduced. In one case the joint was fractured into during the section (Rabagliati[4]). The patient recovered, but with restricted motion in the joint. This is the only case in which this accident has ever been reported. It may have been due to the use of an osteotome of too great thickness, and driving it after it had become tightly wedged.

Ogston's Operation.—Out of one hundred and ten cases, only two are reported to have died—one from septic pneumonia (Baker), and one from uræmia (Thiersch), six weeks after the section. The latter can not be attributed to the operation.

Suppuration is reported by Jones, Schonborn, Sonnenburg, and Margary. In three cases it was considerable. In one it involved the joint, necessitating many incisions and drainage. In one case a troublesome synovitis persisted for some time (Callen-

[1] "Brit. Med. Jour.," April 7, 1877, p. 429.
[2] *Loc. cit.* [3] *Loc. cit.*
[4] "Brit. Med. Jour.," November 24, 1883, p. 1006.

der). In almost all cases there was more or less effusion for a few days. Three patients recovered with complete ankylosis, and one of them with the limb flexed at a right angle, while in four there existed for many months marked stiffness of the knee joint. Acute pain in the knee joint, lasting several days, seemed to have been not an infrequent occurrence.

In one case the saw broke, and was left in the bone. No complication followed.

Reeves's Linear Section with Chisel in Ogston's Line.—In thirty-seven cases, of which record can be found, the ultimate result has been good in all except one (Haward), where the chisel broke in the condyle, and was extracted. Swelling of the knee and thigh followed, with free suppuration, and after recovery the limb was straight while the patient was lying down, but, when any weight was brought to bear upon it, it bent inward. Besides the above case, suppuration has been reported in three others (Holmes, Sterling, and Briddon). Baker[1] states that he has collected fifty-seven cases of Reeves's operations. In one case there was effusion into the knee joint.

Barwell's Linear Section of Femur and Tibia.—In twenty cases, recovery is reported as having taken place in all. Suppuration from the femoral wound occurred in one case, a slight synovitis in one, and the external lateral ligament was ruptured once[2] during the operation. In most of these cases the tibial section was made from three weeks to three

[1] "Brit. Med. Jour.," 1879, vol. ii, p. 3.

[2] Margary, Campenon, *loc. cit.*

months after the femoral; in a few, however, both sections were performed on the same day.

Linear Osteotomy of the Tibia (Billroth).—Of thirty-one limbs on which this operation was performed, in thirty firm union was established. In one case a slight synovitis is reported, lasting six weeks. In one case there was high temperature and great pain, followed by gangrene of the foot, necessitating an amputation at the lower third of the leg (Margary).

Cuneiform Osteotomy of the Tibia (Mayer and Schede).—In twenty-two limbs submitted to this operation, recovery took place in all; in one case osteomyelitis and suppuration followed the operation.

Cuneiform Osteotomy at lower end of Femur (Chiene and Macewen).—In fourteen cases, there was one death from suppuration and erysipelas. At the time of death the bones were united. A good recovery is reported in the remaining cases.

In osteotomies for the relief of genu valgum there have been only three deaths that were due to the operation. Suppuration is reported to have occurred in nineteen limbs. In five cases the joint was stiff to a greater or less degree, in four firm ankylosis took place, and in two amputation had to be performed on account of gangrene of the foot. In nine limbs the result was only an improvement.

ILLUSTRATIVE CASES.

Case I.—Anna A., four and a half years of age, was admitted into St. Mary's Hospital in February,

1881. She has enlarged epiphyses, and gives a clear history of rickets.

Macewen's supra-condyloid operation was performed on both femora March 17, 1881. The limbs were immediately put up in a plaster-of-Paris bandage. A fenestra was cut over the seat of the wounds on the 19th, at which time they were found to have closed, the point of incision being represented by a fine line only. On April 16th the splints were removed. Union firm.

Fig. 28 is from a photograph taken at time of admission; Fig. 29 at date of discharge.

Case II.—George R., colored, aged six years, came

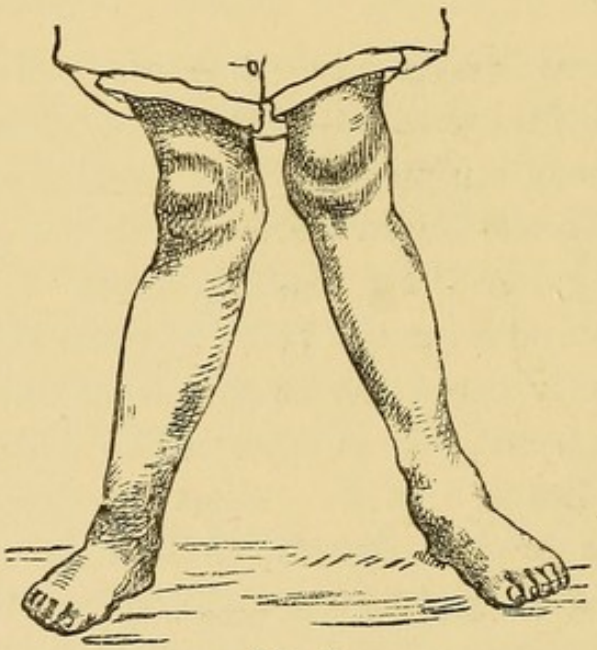


Fig. 28.

under my care in April, 1882. He shows marked rachitic changes in all the long bones. The femurs have an anterior curvature, both internal condyles are much depressed, and there is an acute bend outward just below the epiphysis of the tibia. There

is also an anterior curvature of the bones of the legs. Figs. 30 and 31 are from photographs, and are a good illustration of a marked case of rachitic curvature. Walking is very difficult. There is considerable relaxation of the ligaments.

On May 1, 1882, I performed Macewen's operation upon the right femur, and a linear osteotomy on

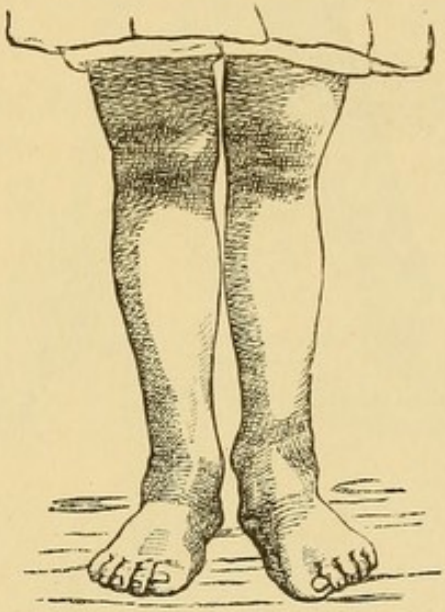


Fig. 29.

the left tibia just below the tubercle. The femoral wound closed, but from the tibial there was some slight suppuration. By these operations considerable improvement was obtained. In October, 1882, the same operation was done on the left femur, and a linear osteotomy on the right tibia and fibula. The limbs were apparently brought into good position. The bones were neither hard nor soft. There was an abscess in connection with the femoral wound which burrowed up under the splint, and was opened on the lateral aspect of the thigh above the plaster-

of-Paris bandage. The operation-wound had closed. After evacuating the matter, the abscess cavity con-

Fig. 30.

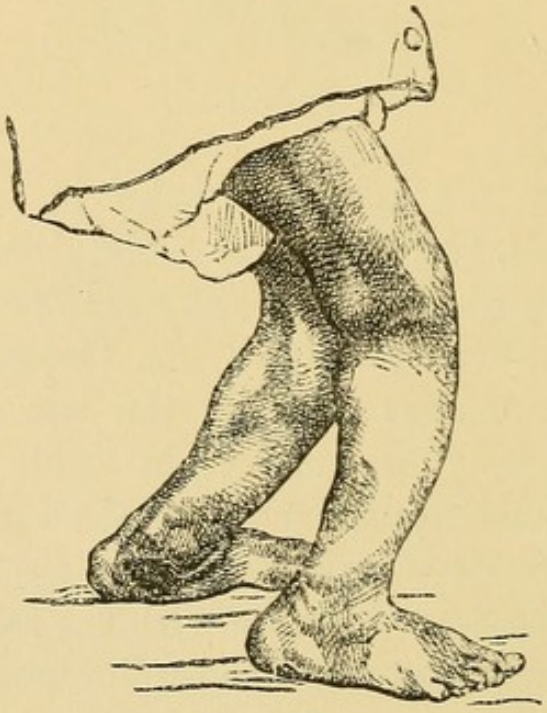


Fig. 31.

tracted down and the discharge ceased. On removing the splints, the deformity was found to still persist, but in a much less degree. During the winter and spring an attempt was made to correct what remained of the deformity with splints, but, owing to the relaxed condition of the ligaments, it was impossible to gain any improvement. During the past summer he was down at the sea-side, where he greatly improved in every respect except the curvature of the bones.

In October, 1883, I made a cuneiform osteotomy

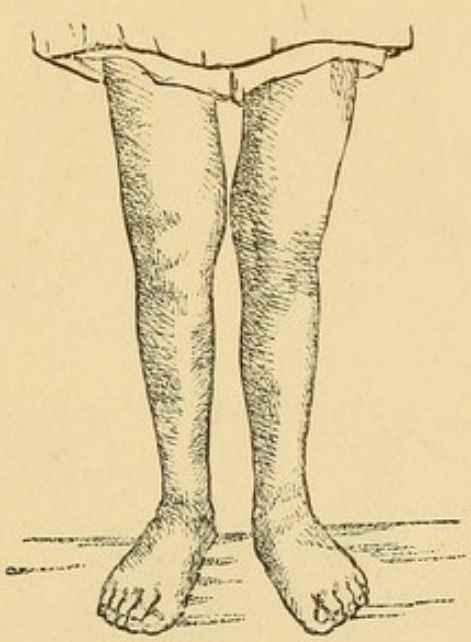


FIG. 32.

of both tibiæ from the inside, just below the level of the tubercle. Sufficient bone was removed to allow the tibia to be brought into a straight line with the femur. The wounds were treated in the usual manner, and horse-hair drainage used. The following day it was removed. There has not been a particle of suppuration. In November, 1883, the splints were removed. Fig. 32 shows his present condition.

There is still a marked anterior curvature of the shaft of the tibia.

This case illustrates one of the worst deformities

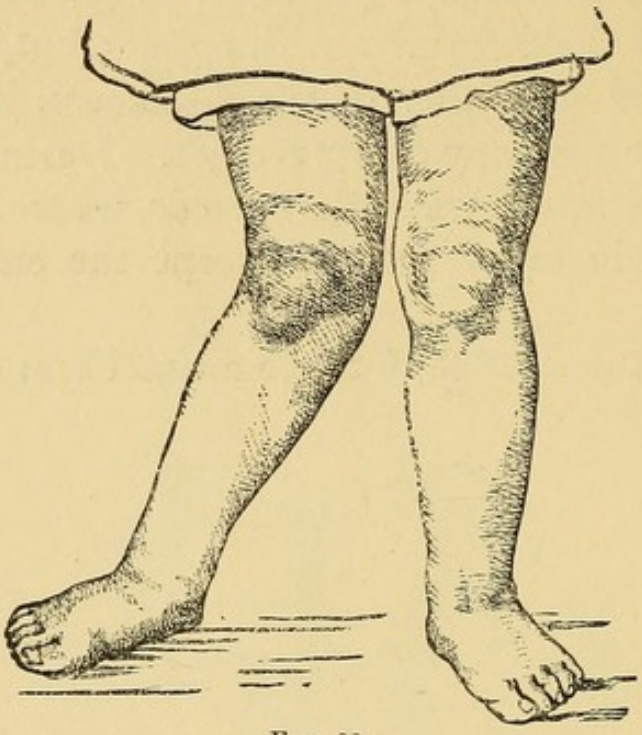


FIG. 33.

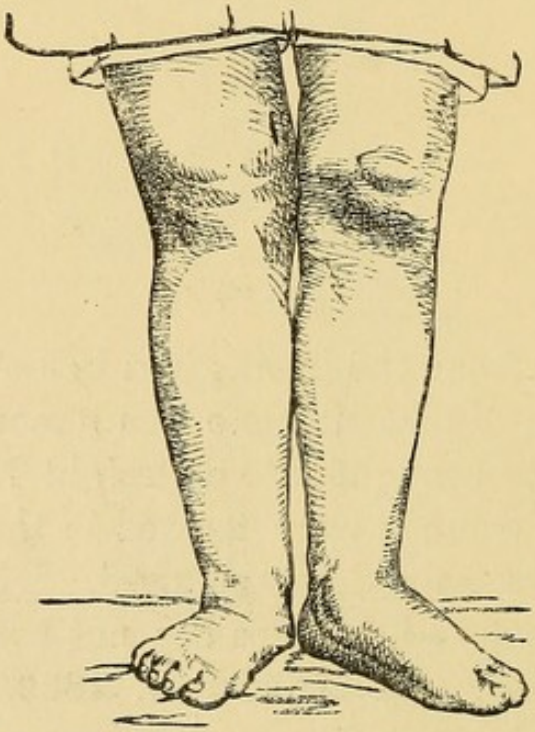


FIG. 34.

I have ever attempted to treat, and is used not so much to exhibit a perfect correction as to show what may be accomplished in so unpromising a case.

Case III.—Lillie B., four years of age, has genu valgum of rachitic origin in right limb, due to a depression of the plane of the internal condyle and

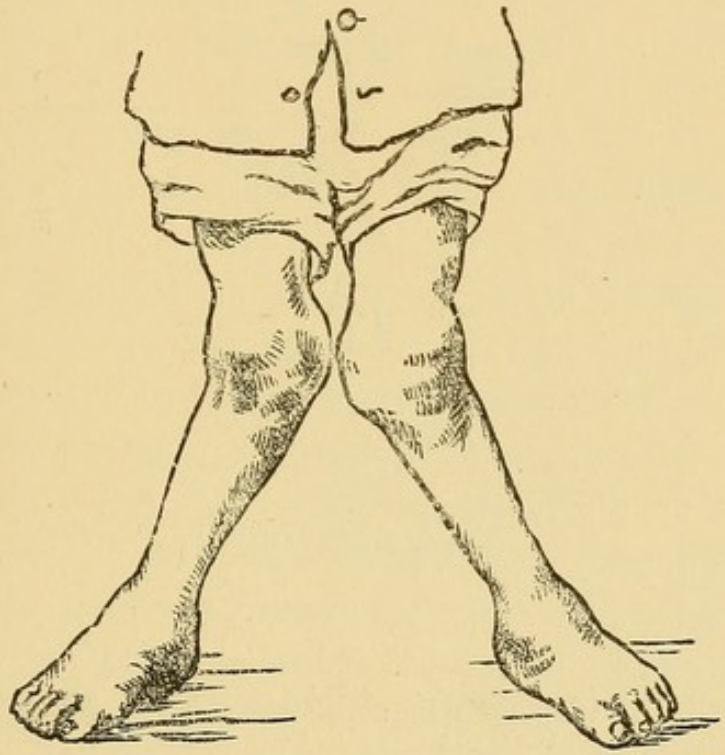


Fig. 35.

some elevation of the inner head of the tibia. Fig. 33 is from a photograph, and shows the extent of the deformity.

On March 14, 1881, a supra-condyloid operation was performed. On examination of the wound on the seventh day, it was found to be represented by a fine line. April 15th the plaster-of-Paris splint was removed, and correction was found to be perfect. Fig. 34 shows the condition of the limb at time of discharge from the hospital.

Case IV.—W. S., fourteen years of age, was admitted into St. Mary's Hospital in February, 1881. He is very small for his age, has misshapen chest and

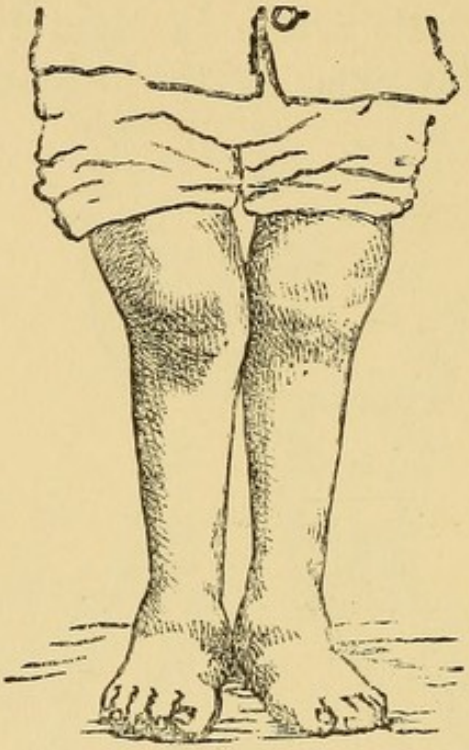


Fig. 36.

other rachitic deformities, together with genu valgum. The ligaments of the knee joint are relaxed. .

Fig. 35 is from a photograph taken shortly after admission, and shows the amount of the deformity.

On February 25, 1881, Macewen's supra-condyloid osteotomy was performed upon both limbs, and immediately put in plaster-of-Paris splints. The wounds were found closed on the 27th, and the splints were removed on the 7th of April, at which time consolidation between the fragments was firm. Fig. 36 is from a photograph taken after he left the hospital.

CHAPTER VI.

GENU VARUM.

Genu Varum has been described by some writers on deformities as the reverse of genu valgum, and that the pathological changes found in the former are similar to those met with in the latter, except that they occupy the opposite side of the limb. This is an error, at least in the vast majority of cases. The deformity in genu varum seldom has that angular appearance so characteristic of knock knee. The whole limb from the trochanter to just above the malleolus forms a long curve, the femur and tibia apparently being equally involved, whose greatest convexity is at the knee joint. There are, however, a few cases that present an angular appearance at the knee joint. I have met one case in which the deformity was due to a lengthening of the external condyle, resembling the condition often found in knock knee. Reeves[1] reports a case of hypertrophy of the external condyle. Genu varum of a marked degree is not as common a deformity as genu valgum, nor are all cases of apparent bowing outward of the limb to be classed as cases of this deformity. Many examples of uncomplicated curvature of the tibia present an appearance of genu

[1] "Trans. Clin. Soc.," London, 1879, p. 32.

varum, but, on correcting the tibial curve, the whole deformity is removed, thus proving that the femur was not involved. Fig. 37 illustrates this. In other examples there may be a slight bending of the femur. Again, a curvature of the thigh may not be observed until the tibial curve has been corrected.

Genu varum may be present in one limb and genu valgum in the other. This deformity may be complicated by other curvatures of the bones of the leg.

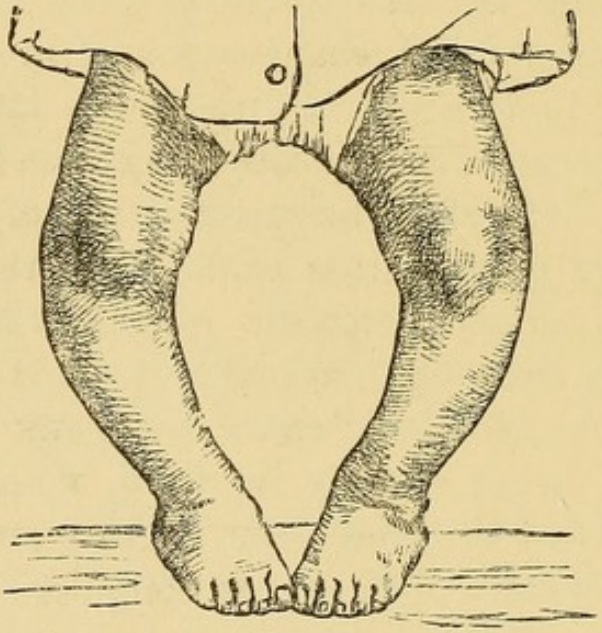


Fig. 37.

The cause of genu varum is rickets, and in the majority of cases the femoral is secondary to the tibial curve.

Patients affected with genu varum to any marked degree walk in an awkward manner, but there is not as much pain from this deformity as from genu valgum.

The elements going to form this deformity being so variable, no strict rule can be laid down as to its

management. The same remarks that were made with regard to the mechanical treatment of knock knee apply with equal force to cases of genu varum. When an operation is called for, it will often be found that a correction of the most marked curve, which is generally the tibial, will remove, or almost remove, the deformity, so that no other section is called for. An osteotomy should be performed at the point of greatest curvature in each bone, and the bone in which the most marked bend exists should *always* be divided first. In marked cases, several osteotomies are necessary to entirely correct.

Theoretically, the section should be made of the tibia from without inward; but, on account of the difficulty of getting at the bone on its outer aspect, and the vessels in close proximity to it in this situation, it is not practical, and its division is made from before backward. The fibula should always be divided first. Section of the femur is best made from the outside.

CHAPTER VII.

OSTEOTOMY FOR ANKYLOSIS OF THE KNEE JOINT.

Osteotomy for ankylosis of the knee joint was first performed by J. Rhea Barton,[1] who made a cuneiform section of the femur at its lower extremity. The late Gurdon Buck, in 1844, modified Barton's operation by including the ends of the femur and tibia together with the patella in the wedge.

Since then other operations have been performed. They can be best considered under—

1. Operations upon the femur.
2. Operations upon the tibia.
3. Operations upon the femur and tibia.
4. Operations upon the joint itself.

1. *Operations upon the Femur.*—Barton's operation, performed in 1835, for bony ankylosis of the knee joint at a right angle, consisted in removing a V-shaped piece of bone, base forward, from just above the condyle of the femur, in the following manner: The bone was reached by an angular-shaped flap, base outward, made just above the condyles, and a V-shaped piece of bone then removed, the apex not extending entirely through the thickness of the shaft. The section was made with a

[1] "Am. Jour. Med. Sciences," 1837, vol. xxi, p. 332.

saw, and the remaining portion of the shaft fractured by bending the leg. The line of incision was closed by sutures and adhesive plaster, and the limb placed upon a double inclined plane. After some days the leg was gradually brought up into a straight line with the femur. The object in not immediately correcting the deformity was that the rough ends of the divided bone might become rounded off by inflammatory action. Quite a number of patients have been operated upon by Barton's method, but modified by the immediate instead of the gradual correction of the deformity.

Kilgarriff,[1] in a case of ankylosis at a right angle following extensive injury to the knee, slightly modified Barton's operation by making a complete section of the bone. His reasons for this mode of operating were that the skin over the knee had been entirely replaced by cicatricial tissue, and he desired to remove more bone than a strict Barton's operation would accomplish. Schillbach is reported by Heyfelder (p. 108) to have made a complete resection with a chain-saw of a wedge-shaped segment of the femur. Pancoast[2] operated upon the shaft by perforating the bone in different directions in the line of desired fracture with a gimlet through a small wound, and then breaking the bone. An abscess formed at the seat of operation, but eventually the patient made a good recovery, the limb being nearly in a straight position. In the following year Brainard, of Chicago, operated upon the condyles, the bone at this point being perforated by an instru-

[1] "Dub. Med. Jour.," March, 1880, p. 189.

[2] "Med. and Surg. Reporter," March 5, 1859, p. 408.

ment devised for this purpose. He was unable at the time to fracture the bone, but some days later, after inflammatory action had been set up, the bone easily gave way. Stephen Smith[1] attempted to perform Brainard's operation, but was unable to fracture the bone, even after inflammatory action had lasted for some time.

Langenbeck, in 1862, practiced subcutaneous osteotomy above the condyles by means of his perforator and small saw, but the operation can not be considered a strict subcutaneous one as such sections are now peformed.

Barwell[2] performed a linear osteotomy with a chisel, two inches above the lower end of the femur, for the correction of angular ankylosis at the knee joint, with excellent results. A few months later Macewen, in April, 1875, operated antiseptically in a knee joint in a similar manner.

2. *Operations upon the Tibia.*—Wahl, of St. Petersburg, in 1877 performed a cuneiform osteotomy upon the tibia just below the tubercle for the relief of a knee ankylosed at a right angle. The operation was followed by suppuration and necrosis. Margary repeated this operation, but with better success. It does not seem to have been a favorite operation, and has had but few advocates.

3. *Operations upon the Femur and Tibia.*—This includes cuneiform excision of the ankylosed joint and linear osteotomy of both bones. Buck,[3] in 1844, modified Barton's operation by removing a wedge-

[1] "Am. Med. Times," 1860, vol. i, p. 310.
[2] "Brit. Med. Jour.," April 28, 1878, p. 807.
[3] "Am. Jour. Med. Sciences.," October, 1845, p. 277.

shaped piece, which included the articular ends of the femur and tibia, together with the patella, and immediately rectifying the position of the leg. The apex of the V-shaped section did not reach the posterior portion of the bones, a bridge of bone being left, which was fractured. The object in this was to obviate any danger of injury to the popliteal vessels. The operation is really an excision of an ankylosed joint. It has been adopted in the vast majority of cases of bony ankylosis of the knee joint at an angle, and records of its success are scattered through the medical journals since the day of its first performance.

Entriken[1] deviated from Buck's operation in that he included the whole thickness of the bones in the section on account of the marked contraction of the tissues behind the joint, requiring the removal of more bone than was possible by Buck's section. The same end, however, could have been accomplished by making the cuts as designed by the first operator, and then removing additional pieces until the necessary amount of bone had been removed. Buck's operation is certainly a safer one in that the vessels are protected by a bridge of bone from the saw.

In marked cases of deformity at the knee joint submitted to a linear osteotomy, most operators have advised and practiced two sections: one at the lower end of the femur, by which half of the desired correction was obtained, and later a division of the tibia just below the tubercle, by which the remainder of the deformity was removed. The advantage of this operation is that the shortening of the limb is not increased, while, on the other hand, it leaves the

[1] "The Clinic," March 12, 1876.

joint prominent and misshapen. Time will, however, diminish this deformity to some extent. In correcting after a linear osteotomy there is an entering angle left on the posterior aspect of the bone, its size varying with the amount of correction made. This in time is obliterated by the formation of new bone.

There have been two operations performed upon the joint itself, in order to break up the bony bands between the bones. In 1861 Gross[1] performed a subcutaneous operation by entering the joint itself with a perforator and after dividing or breaking up all adhesions, placed the limb in the desired position, the operation being performed through an incision one half an inch long. He reports six successes out of seven patients operated upon. Stromeyer Little,[2] in 1868, divided the uniting bands between the femur and tibia, in a case of bony ankylosis of the knee joint, with a carpenter's chisel, one fourth of an inch wide, through a small incision, and then brought the leg into a straight position. The wound closed without suppuration by the sixth day. Dr. H. B. Sands, of this city, has, I believe, performed a similar operation. Of these operations for correcting ankylosis of the knee joint at an angle, that of Buck (cuneiform osteotomy), removing a V-shaped piece from above the joint, and linear osteotomy of the femur and tibia, are mainly practiced. Buck's operation does not properly belong to osteotomies, but rather to excision.

Linear osteotomy for angular deformity at the

[1] "System of Surgery," 1882, vol. i, p. 1096.

[2] "Medico-Chir. Trans.," vol. iv, p. 247.

knee joint is performed as follows: The limb should be rendered bloodless, and a small incision made by the side of the rectus tendon, at a point a finger's breadth above the upper portion of the external condyle, of sufficient length to admit the osteotome. This latter instrument is then passed down upon the knife as a guide, and the femur divided as in other osteotomies until it can be easily fractured. If the deformity is great, it is well to make in addition a section of the tibia just below the tubercle, and divide the amount of correction between the two bones. Barwell makes the section of the tibia two weeks later, while Macewen operates upon both bones upon the same day. The nearer to the joint the section is made, the less will the knee project after the correction is made. In time, however, the deformity is diminished by rounding off and filling up any projection and depression, so that in a year after the operation the appearance of the limb has greatly improved. The shortening of the limb is less than after a cuneiform osteotomy. Macewen reports no shortening in some of his cases.

The only accident after a linear osteotomy that I have seen mentioned is gangrene from compression of the popliteal vessels from the acuteness of the bend after straightening the limb.

I have never performed the operation of simply dividing the bone. I think that a Buck's operation is the safer and better.

CHAPTER VIII.

OSTEOTOMY FOR TIBIAL CURVES.

Tibial curves may be studied under three conditions: rachitic, traumatic, and pathological. As in other deformities of the long bones, the vast majority of cases of bending of the bones of the legs are included in the first class. Rachitic curvature of the tibia and fibula belong to the earlier manifestations of this disease, and usually begin before the third year. Their cause is mechanical—standing; sitting with their feet bent under, or cross-legged, a very common position for a child affected with rickets to assume; sometimes the way in which they are carried by their nurse is a factor in the production of these deformities; in fact, almost any position will produce a curvature of these bones in a young child affected with rickets. I have never been able to satisfy myself that the muscles of the limb were an active element in their production.

Curvatures of the tibia may be lateral, anterior, or antero-lateral. The bending may be confined to the lower third of the bone, just above the malleolus, where a sharp, almost angular curve may be found; it may involve the whole bone, from just below the upper epiphysis to the malleoli, or there may be a

sharp, short curvature at its lower third, and then a long one above, or the bone may have only one long anterior curve. In marked cases the tibia is often flattened from before backward, or from side to side. In the latter cases the spine is much sharper and seems more prominent. In anterior curvatures the bone is often elongated on its anterior border, and overhangs the foot (as in Fig. 38). Lateral curva-

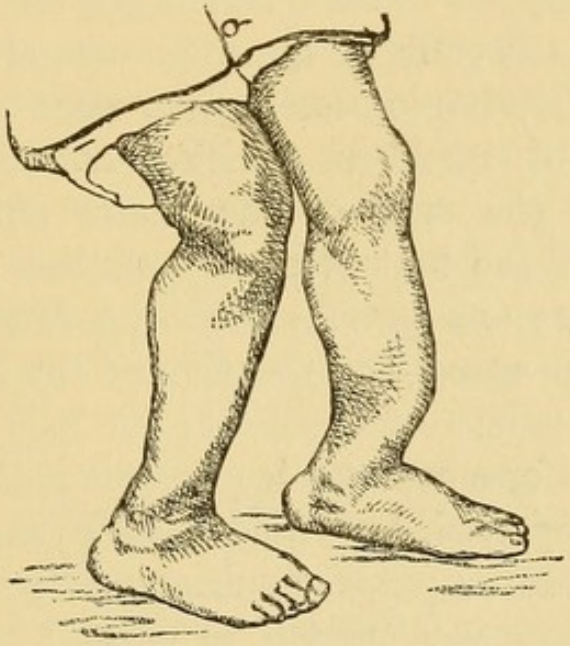


Fig. 38.

ture of the tibia and fibula with that of the femur, form genu varum.

Traumatic deformities of these bones have their origin in fractures, which, for one reason or another, have been allowed to unite at an angle. To this class belong intra-uterine fractures. These are almost always angular; some few cases of simple bending are reported. Deformities from this cause are not as frequently met with as formerly, owing to improved methods of treating these injuries. The greater portion occupy the middle third, and next in frequency

we find malposition of the foot, due to fracture of the lower portion of the fibula and a chipping off of the internal malleolus (Pott's fracture), the foot being turned outward. Thus, in seventy-four cases, fifty-one occurred in the middle third and twenty-three in the lower portion of the limb. Operations for the correction of vicious union of the tibia and fibula above the lower portion may be resolved into three—a simple section, a cuneiform section, and an excision of the ends of the fragments after a simple division. Of simple section nine cases are reported, twenty-six of cuneiform excision, and fifteen of an excision of the ends of the bones after a linear section. Of the first class, suppuration is reported in ten cases; one patient died—no cause assigned; and six were cured—no mention of the formation of pus being made.

Of cuneiform osteotomies, in nine patients suppuration is reported, two died from pyæmia; in two the limb was amputated subsequently; in one the femoral artery was ligated to control hæmorrhage; and thirteen are reported "cured"—no mention being made of suppuration.

Of re-excision of the ends of the bone after a simple division, in six cases suppuration is reported; one patient died from pyæmia; in one the limb was amputated some time after the operation for non-union; and in six no accident is reported.

There have been three operations performed for the correction of the malposition of the foot after a Pott's fracture—namely, an excision of the lower end of the tibia, with a division or osteoclasis of the fibula; an excision of the internal malleolus, with

fracture of the fibula; a cuneiform osteotomy, base inward, on the inner aspect of the tibia, and a linear section, or simple fracture of the fibula. The latter operation has lately been performed by Fenger,[1] of Chicago. The result of these operations has been to bring the foot inward and so to allow its axis to correspond with that of the knee and hip joint. Of twenty-three patients on whom these operations have been performed, in twenty-two recovery took place, with a useful foot, and one died on the tenth day from purulent infection. In five of these suppuration is reported to have occurred; in two, however, it was only slight. In some of the cases the ends of the bones have been wired together, but recovery does not seem to have been any more perfect than in those in which this was not done. It is probable that suppuration occurred in more cases than those given above, as the majority of cases were operated upon before the present methods of operating and management of wounds were adopted.

In 1861, Berend, of Berlin,[2] reported a case of marked deformity after a fracture, with ankylosis of the ankle joint, in which he performed a cuneiform osteotomy at the lower portion of the tibia with good result. Billroth [3] reports a similar case.

Pathological.—In this class are included those cases of bending of the bone from local diseases—as inflammation of bone. Schede reports the case of a girl with congenital syphilis who had had a chronic periostitis of the tibia for nine years, with

[1] "Med. News," April 15 and 22, 1882.

[2] Campenon, loc. cit., p. 186.

[3] "Wien. med. Wochenschrift," 1881, p. 414.

elongation of the bone, eight to nine centimetres, the fibula not being affected. The tibia was curved, with its convexity inward. Willitts[1] mentions a case in which the tibia was bent at an acute angle outward, following necrosis of the outer portion of the shaft, near the epiphysis. Similar cases may be found scattered through medical literature. These deformities are due to an increased growth of a portion or the whole of the bone, and consequent bending due to the unequal growth of the fibula. It is met only among children and adolescents.

It is rather a common belief among parents, and to some degree among physicians, that children affected with these curves of the bones of the leg will outgrow the deformity, and that all local treatment is uncalled for. It does not seem possible, while a child is running about, that any real obliteration of these curvatures could take place. They may, and certainly do, in some cases, undergo a relative change; the bone increases in length and thickness, while the curve remains the same size as at first, so that it is relatively smaller and less marked in later years. This is especially true of short, sharp curves at the lower end of the tibia. In later years these are apparently smaller and less observable. Long anterior curves do not show the same tendency to become obliterated. They seldom, if ever, diminish, and, when the limbs are uncovered, will always be noticeable.

Treatment.—The same remarks are applicable to curvatures of the bones of the legs due to rickets as to the deformities of other long bones of similar

[1] "Brit. Med. Jour.," February 1, 1879, p. 151.

origin. While the bone is soft, lateral bending of the limb may be straightened by splints; but, after they have become hard, mechanical treatment is useless. Anterior curvatures are not suitable for mechanical treatment, for the reason that pressure can not be applied over the crest of the tibia, the sharp edge of the bone cutting through the skin. It is true that in catalogues of instrument-makers, and in some works on surgery, braces are figured for application over the crest of the tibia to correct anterior curvatures; but they are entirely useless.

When the bones are only moderately sclerosed, time may be gained by putting the patient under ether and forcibly straightening the limb, and then putting it up in plaster of Paris. Mr. Howard Marsh speaks well of this plan. I have adopted it in some cases, and think it an advantage.

After the bones have become hard, osteotomy or osteoclasis must be performed. The latter method will be treated of in another chapter. Osteotomy for bow-legs may be either linear or cuneiform. All lateral and anterior curvatures of slight degree may be corrected by a linear osteotomy; anterior curves of marked degree by a cuneiform section. Osteotomy for these deformities should be made at the point of greatest curvature. In all cases the fibula should be divided *first*, using a small osteotome, because the bone is difficult to steady after the tibia has been fractured, and in cuneiform sections the less the parts about the tibia are disturbed the better. It will be found easier to make the section of the fibula upward and inward. In performing the tibial section, the incision should be made down upon the crest at the

point of greatest curvature parallel to the long axis of the bone, the instrument introduced and rotated so as to be at right angles with its line of entrance. It is best to begin to divide from the crest inward. Care should be taken that the edge of the osteotome does not extend beyond the outer border of the crest, as the anterior tibial artery may be nearer to the bone than normal, and is liable to be divided. I had this accident happen to me in my first case. After the bone has been divided through about two thirds of its thickness, the section can be completed by fracture. The wounds are to be treated in the manner pointed out on page 22. I think it well to make a counter-opening on the inner side of the leg and pass horse-hair through for the purpose of preventing any accumulation of blood separating the edges of the wound. The tibia being superficial, there is not as much room for the effused blood as in bones better covered with muscles, and I have always found that it is liable to force the line of incision open. In simple lateral curves the thinnest osteotome should be used, as the cut in the bone should be as narrow as possible.

Cuneiform Osteotomy.—Anterior curvatures, if marked, are best corrected by the removal of a wedge-shaped piece of bone. The more angular the deformity, the less will linear section correct. A counter-opening should always be made on the inner aspect of the leg, opposite a point corresponding to the apex of the wedge, and carbolized horse-hair be passed through the cut and out of the operation wound. An easy way to accomplish this is to pass a pair of dressing forceps (closed) down, through, and below the

divided bone, and, by a twisting motion, force the end beneath the skin at the point where it is intended to make the counter-opening. The blades are separated and the skin divided between them. The horse-hair is then caught in, and the forceps drawn up through the original incision. The edges of the cut on the anterior aspect of the leg are to be united with antiseptic gut, and over this a small compress, the wound having been first washed out with some antiseptic. I have used iodoform, dusted over the wound, but any similar method of wound-dressing may be adopted. The whole limb and lower portion of the thigh is then incased in a plaster-of-Paris splint. Before this becomes hard the limb is put into the desired position. It is well to over-correct a little, as after a time the plaster splint becomes loose and allows the position of the limb to be altered. In this class of cases a tenotomy of the tendo Achillis is often necessary. The horse-hair should be removed upon the second day through a fenestra cut over the situation of the wound. Its removal causes no pain. The method of performing a cuneiform osteotomy has been given with much detail, because I am satisfied, from personal experience, that its success—that is, primary union of the wound—depends much more upon the manner of dressing than upon the way in which the section of the bone is performed. In the first five cases, eight limbs, in which I removed a wedge-shaped piece for anterior curvature of the tibia, suppuration, more or less extensive, occurred in all the limbs. On examination of the wound on the second day, blood was found to have been effused and to have burrowed up under the skin to a con-

siderable distance. The edges of the wound were separated by the blood, and, notwithstanding the use of strict antiseptic precautions in some cases, suppuration invariably followed, and in one or two cases counter-openings had to be made. Drainage from the wound itself did not seem to obviate the difficulty. Since I have adopted the plan mentioned above the course of the wound has been similar to those after a simple osteotomy. I have never seen a drop of pus. In one case I removed a wedge-shaped piece of bone from the inner side of the tibia just below the epiphysis in order to correct an angular deformity at that point; the wound closed by primary union. The pinching of a piece of muscular and cellular tissue between the fragments may cause suppuration.

The hæmorrhage following a cuneiform osteotomy is much greater than after a simple section of the bone. Other things being equal, I think that suppuration is more liable to follow an osteotomy, be it either linear or cuneiform, of a bone that is subcutaneous, than of one that is well covered with muscles, and I attribute this to the fact that in the former case any great accumulation of blood is sure to cause tension on the wound and prevent primary union. Therefore, the more subcutaneous the bone, the greater is the necessity for a counter-opening and good drainage.

Complications.—There have been two deaths reported after an osteotomy of the tibia and fibula, one by Muralt[1] in a young girl who died, some days after the date of the operation, from diarrhœa The

[1] Bœckel's Tables.

autopsy revealed nothing to account for the fatal result. Gould[1] reports a fatal case in a healthy boy, eight years of age, death being due to carbolic-acid poisoning thirty-six and a half hours after the operation. In neither of these cases can the fatal result be attributed to the operation itself.

In two hundred and fifteen cases of osteotomy tabulated by Bœckel and Campenon, an excessive hæmorrhage occurred in four, in forty-one suppuration took place, and in fifteen a limited necrosis of a portion of the cut surface is reported. Volkmann[2] mentions a case in which he amputated a limb on account of an enchondroma, having its origin at the point of section. I have lost two patients from inter-current disease after firm union had taken place, the fatal issue being in no way connected with the operation: one from diphtheria, and one from meningitis.

In regard to the liability of the deformity to return after an osteotomy, in one case only have I seen it, and that was in a boy five years of age, on whom a linear osteotomy was performed on both limbs for lateral curvature of the tibia. He was an inmate of an asylum. The bones were quite hard. He was discharged with limb straight and union firm. Five months later he was returned to the hospital with an angular anterior deformity at point of section, with the statement that it had only recently appeared. The boy at the time of re-admission was in poor condition. It would seem probable that the angular deformity was due to softening of the callus, owing to improper food, and not to bend-

[1] "Brit. Med. Jour.," May 28, 1881, p. 850.

[2] "Berl. klin. Wochen.," 1877, No. 40, p. 591.

ing from a soft condition of the bones. Billroth reports one case, of a child four years of age, in whom the deformity (lateral curvature of the tibia) returned after some months.

ILLUSTRATIVE CASES.

Case I.—M. P., four years of age, was admitted into St. Mary's Hospital, January, 1879, with a marked antero-lateral curvature of both limbs, of rachitic origin, most marked at their lower third.

In February a linear osteotomy was performed upon both tibiæ, a section of the fibulæ having been first done. A counter-opening was made on the inner aspect of the limb, and carbolized horse-hair passed through. The limbs were put upon a temporary splint, and, after the wound had closed, a plaster-of-Paris dressing was applied. This was kept on until consolidation had taken place, when she was allowed to get up and use her limb.

Figs. 39 and 40 are from photographs taken before and after section.

Case II.—G. H., four years of age, was admitted into St. Mary's Hospital, in 1882, with a marked curvature of the bones of both legs at their lower third. The bones have a lateral, with a marked anterior bend, so that the crest of the tibia overhangs the ankle joint. In February osteoclasis was performed upon both limbs, but only the lateral curve could be corrected. The limbs were immediately put up in plaster of Paris in a straight position as regards the lateral bend. In May a cuneiform osteotomy was performed upon both tibiæ, and a linear on the fibulæ, counter-openings were made,

carbolized horse-hair passed, and the lips of the tibial wounds were united with carbolized catgut. On the following day the horse-hairs were removed. The

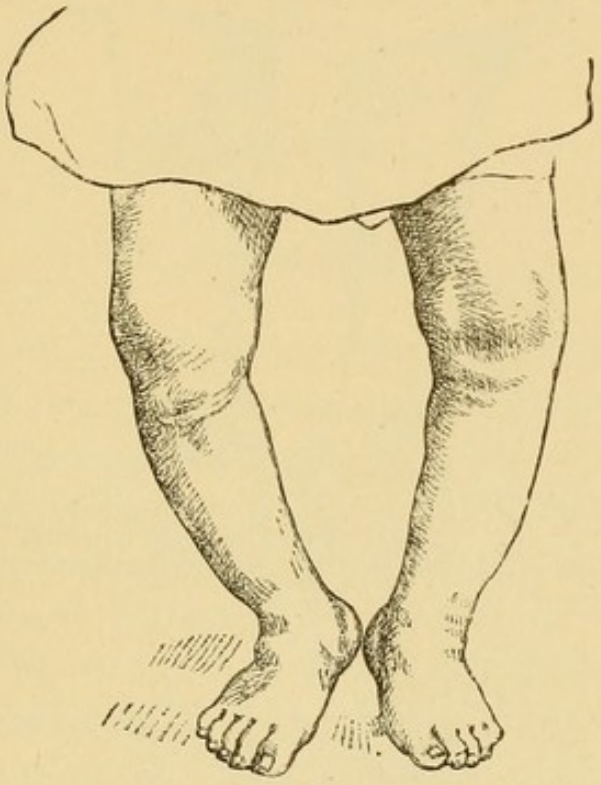


FIG. 39.

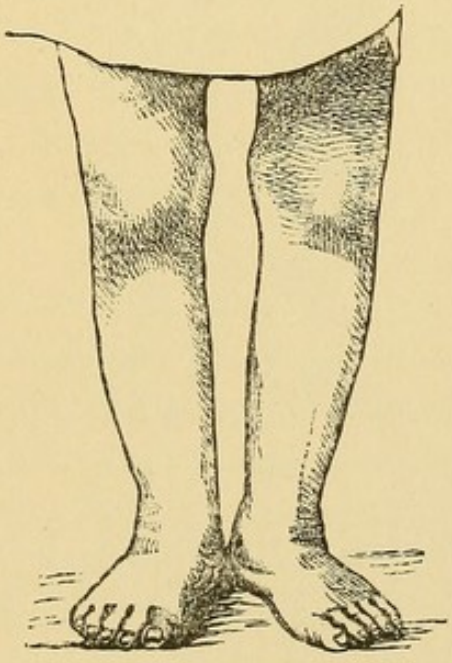


FIG. 40.

wounds healed by primary union. The temperature was never above 99°. In four weeks the splints

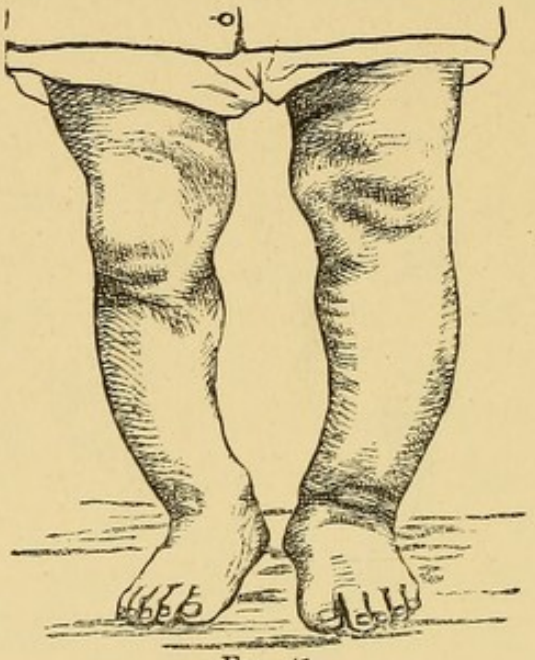


Fig. 41.

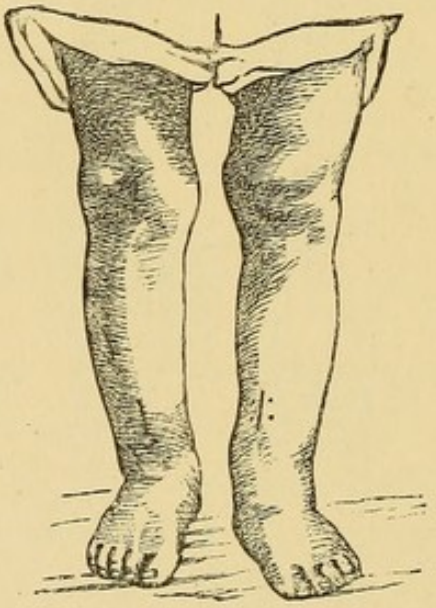


Fig. 42.

were removed, and the union was found to be firm. Figs. 41 and 42 show the deformity, and correction obtained.

CHAPTER IX.

OSTEOCLASIS.

The correction of deformities of the long bone by fracture is an old operation, and its history dates back to the time of Hippocrates.

Osteoclasis may be either manual or instrumental. Cases appropriate to the former procedure are deformities after fracture and bending of the long bone, in the one before union is firmly established, and in the other while the bones are in a pliable condition. In this class should be included cases of fibrous, and some of bony ankylosis of joints—and "*redressement brusque.*" To instrumental osteoclasis is applicable all cases of deformity after fracture and curvature of the long bones, where perfect consolidation in the one and sclerosis in the other has taken place.

The cases that can be corrected by manual osteoclasis are comparatively few, and even in those in which it is possible to correct without the use of an apparatus for the application of power, the latter is better, on account of the precision with which the point of rupture can be determined. Fracture, or bending of the bones of the legs, even in quite young children, is more difficult than is supposed.

To the operation by means of an osteoclast belong the vast majority of cases of deformities. Osteoclasis without an instrument requires but a brief notice. The cases to which it is applicable are so apparent that their recapitulation would be useless except for the correction of certain deformities at the knee joint. I refer to genu valgum and genu varum. Although *redressement brusque* does not belong to the same category as forcible correction of fracture, yet its consideration in connection with osteoclasis seems appropriate. The method was first advocated for rachitic curvature by Guérin[1] in 1848; later, M. Delore, of Lyons, applied this procedure to genu valgum and genu varum. It has been a favorite operation among the surgeons of the French school, while osteotomy has had its chief advocates in England and Germany.

The object of Delore in *redressement brusque* was to cause a partial diastasis between the diaphysis and epiphysis at the lower portion of the femur, and then to slide the epiphysis together with the tibia inward, and thus correct the deformity. Delore's method of operating is as follows: The patient, being fully under the influence of an anæsthetic, is placed on the side on which the limb to be operated upon is situated, with the external malleolus and the upper portion of the thigh resting firmly on the table. Then, by sudden and repeated applications of force by means of the hand placed on the apex formed by the deformity, the knee is forced outward until the leg assumes its normal relation to the thigh. The operation is performed slowly and progressively, the time

[1] "Gaz. Med. de Paris," 1848, p. 743.

required to obtain restitution varying from five minutes to half an hour. In young children only a very moderate pressure is required, while in persons of eighteen or twenty years great force is necessary. M. Taillaux operates by placing the patient upon the opposite side, resting the knee upon a cushion, and, using the leg as a lever, forces the lower limb into the desired position. The deformity gives way with a series of cracks. The lesions produced by this operation differ somewhat in different cases. Yet they are all of a serious nature, and are accompanied at least by effusion into the joint, and often by inflammation. In a patient of Delore's who died of measles twenty days after a *redressement brusque* for genu valgum, it was found that the lower epiphysis of the femur had been partially detached; there was considerable ecchymosis under the periosteum on the anterior aspect of the femur; the external portion of the epiphysis of the tibia had been loosened, and the end of the fibula torn off and dragged upward by the external lateral ligament. Frequently the internal condyle of the femur or inner head of the tibia is flattened or crushed in by the amount of force employed, while the periosteum is torn and detached. In older subjects, fracture of the shaft has been produced, or rupture of the external lateral ligament. Inflammation of the knee, more or less intense, has followed the operation. Notwithstanding the apparently severe nature of the immediate effects of the operation, in two hundred and fifty limbs operated upon by Delore he reports no accident; and states that in about one year all traces of the operation have disappeared. But even then the patient has to

be kept under observation many months, and a return of the deformity is by no means exceptional. Serious inflammation of the joint and suppurative periostitis of the shaft of the femur have been reported. Delore has operated chiefly upon children. It is reported that the injury to the ends of the bones entering into the formation of the knee joint has not been followed by arrest of development in the limb. It would appear that the nearer the patient approached adult life, the more serious and difficult the operation is.

Redressement brusque for genu valgum has had but few, if any, advocates in this country. That it has not been more frequently followed by serious joint disease with disorganization of the articulation is a matter of surprise. Perhaps the explanation is that the operation has only been performed in selected cases, on patients who were in good health and with no predisposition to tubercular affections. The fact that the exact nature of the lesions produced in any single case are so uncertain, and the time necessary to regain use of the joint so long, has deterred most surgeons from adopting this operation; and now that a much better and more precise method of correcting genu valgum and genu varum has been devised in osteotomy, it is probable that *redressement brusque* is an operation of the past.

Rushton Parker[1] has reported some cases of curvature of the femur and genu valgum treated by osteoclasis of that bone. His method is as follows: The knee joint was fixed in an extended position by means of well-padded iron splints, enveloping the

[1] "Med. Times and Gaz.," December 29, 1883.

upper half of the leg and the lower portion of the thigh, so that the part of the limb below the curve or desired point of fracture should be perfectly immovable and serve as a lever. The thigh was then laid on its outer side, the upper part being held firmly down on the table, the point of desired fracture just on the edge, and the rest of the limb projecting beyond. Then, by using the latter portion of the limb as a lever, fracture was readily produced at the desired point. He mentions a troublesome synovitis of the knee joint in one of his cases as a result of the operation.

Rupture of ankylosed joints is a serious operation. Its dangers, however, are different for different articulations, and vary with the nature of the uniting medium. In joints presenting extensive bony surfaces, and in which bony union has taken place, forcible rupture is a grave operation. It is often impossible to cause a separation between the bones, and fracture may take place at a point on either side of the joint and produce a deformity in no way an improvement on the one it was sought to relieve. It is not a safe operation for bony, and is a very questionable one in fibrous, ankylosis of the hip joint. In the former case the enormous power, when the pelvis is fixed, that can be brought to bear upon the upper end of the femur will certainly produce a fracture if the attempt is persisted in, but at what point depends upon where the bone is the weakest. In fibrous ankylosis after suppurative coxalgia, as said before, it is too hazardous an operation. In the knee joint excellent results have followed forcible rupture, and, if the band be fibrous, some useful motion is

often obtained. It is not entirely devoid of danger to the popliteal nerve and vessels behind the joint, injury to which has been recorded. When there is much cicatrical tissue behind the articulation, the danger that the important structures in that situation may be torn is not slight if persistent force is employed. It is questionable whether an osteotomy would not be a better and safer operation in this class of cases, be it linear or cuneiform. In this case, however, a movable joint is not a possibility.

It should be stated, however, that in ankylosis of the hip joint after disease, excellent results from forcible fracture have been recorded by M. Broca,[1] Laborie,[2] Tillaux,[3] and by other surgeons in England and in this country. Yet its dangers, especially after coxalgia, are by no means slight. Disastrous results have been too common, and its results compare very unfavorably with those of osteotomy.

Osteoclasis by means of an apparatus by which considerable power can be applied has been advocated by all writers upon surgery, and many instruments have been devised for this purpose. The earlier operations were restricted to the correction of fractures of the long bone united at an angle, but later surgeons have extended the operation to deformities of the limbs due to other causes. Busch, Louvier, Maisonneuve, and others, have invented instruments for the purpose. In 1846, Rizzoli devised an osteoclast, which, with some modification, is still used. Its introduction into this country is due to

[1] "Bull. de la soc. de chir.," Paris, vol. i, 1860, p. 243.
[2] *Ibid.*, p. 235.
[3] *Ibid.*, 1875, p. 353.

Dr. A. T. Cabot, of Boston.[1] It consists (Fig. 43) of a heavy bar, fifteen inches long, one inch wide, and three eighths of an inch thick, being much thicker in the center, which is pierced for the female portion of a screw. Into this is fitted a round steel bar, one half an inch in diameter, on which is cut a thread corresponding to the nut on the long bar, and furnished at its upper portion with a handle; and at its lower

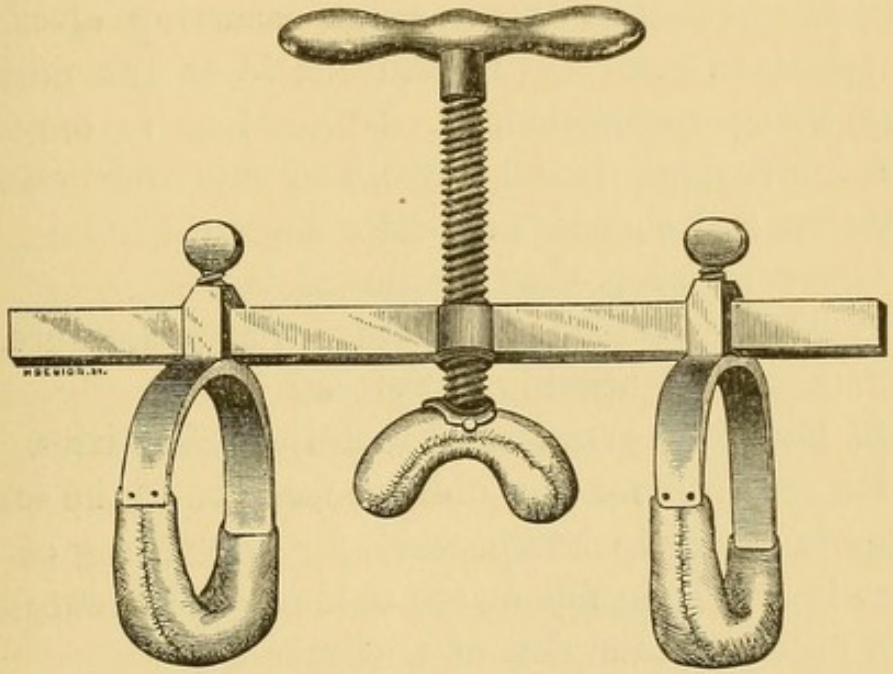


Fig. 43.

extremity is a strong, well-padded steel plate or crutch, forming a segment of a circle. The portion of steel forming the male part of the screw turns in a socket on the upper side of this crutch. Two steel rings, five inches in diameter, one inch wide, and one fourth of an inch thick, having at their upper portion a slot into which the large bar slides, and to which they are fixed in any desired position by bind-

[1] "Boston Med. and Surg. Jour.," August 14, 1879, p. 217.

ing screws. The lower segment of these rings are well padded with flannel and covered with chamois.

In order to increase the rapidity with which the force can be applied, I have had three threads cut upon the upright bar, which forms the screw.

Dr. C. F. Taylor, of this city, has devised an osteoclast—which is described in the "Medical Record" for April 21, 1877, p. 241—for fracturing the femur in a case of bony ankylosis with marked abduction and flexion of the thigh occurring after hip joint disease. As the instrument is at the present time being remodeled, a description is omitted. The instrument is an excellent one for certain purposes, and should be better known.

Osteoclasis has been employed for—

1. The correction of deformities after fracture.
2. For straightening ankylosed joints.
3. For the correction of rachitic deformities.

Rizzoli produced an oblique fracture of the sound femur in order to compensate for shortening of the other limb. I am not aware that any other surgeons have followed this plan of treatment.

Osteoclasis for deformity of the long bone after fracture has been performed by many surgeons, and instruments of various designs have been devised for this purpose. It is an operation that is attended with but little danger, and has yielded excellent results. Thus, in Gurlt's statistics[1] the femur was fractured fifty-three times, the leg twenty-four, without an accident, and with a good result as to its function and use. The records of hospitals will furnish many examples of this method of correcting

[1] "Arch. gén. de méd.," September, 1875, p. 338.

deformities. The results and technique are so well known to practical surgeons that an extended notice is not called for. Osteoclasis for deformity after hip joint disease by means of an instrument has been performed. Most of the apparatuses used for this purpose have been devised for fracture near the joint at an uncertain point. Taylor's osteoclast was devised to produce a fracture at a point entirely under the control of the surgeon. From the anatomical position of this articulation it is impossible to select a point above the junction of the middle with the upper third, and herein is the defect of the osteoclast of Dr. Taylor. The fracture is at a point so far from the joint that the resulting deformity is considerable, and increases the amount of shortening.

Fig. 44 is from a case reported in the "Medical Record," April 21, 1877, p. 242, and shows the amount of deformity after the use of this osteoclast.

Osteoclasis for the Correction of Curvature of the Leg of Rachitic Origin.—For certain curvatures of the bones of the legs osteoclasis is to be preferred to any other operation, in that it does away with all cutting and takes but little time for its performance. For the past three years I have abandoned osteotomy for long lateral and antero-lateral bending of the bones of the leg. I do not think that anterior curvature or acute bends near the epiphysis are well adapted to this means of treatment, for reasons that will be given farther on. I use Rizzoli's osteoclast, as described on page 155.

The method of using it is as follows: The patient being placed under ether and the desired point of

fracture having been determined, the limb is passed through both rings, which are adjusted on the straight bar so that one shall be just above the lower and the other just below the upper epiphysis of the tibia. The semicircular pad should be directly over

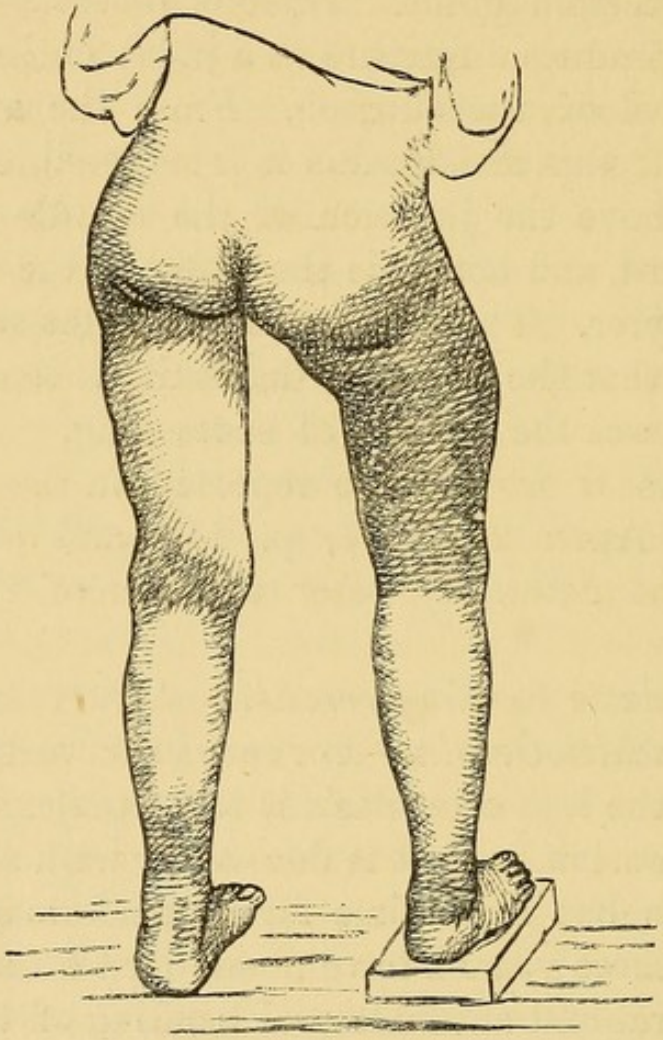


Fig. 44.

the point of desired fracture on the outer aspect of the limb. It makes no difference whether the steel plate at the end of the screw is equidistant from the two rings, the point of fracture takes place immediately under it, no matter where it is placed, pro-

vided it is far enough from one of the rings to allow sufficient space. I do not think that I have ever had less space than two inches. I think it safe to place several layers of flannel over the points of pressure and counter-pressure. After the instrument is adjusted it is made tight with a few turns of the screw, and then the pressure-pad is driven down rapidly by turning the screw until the bone gives way. It has been found that with the instrument the fracture always takes place directly under the pad, and is transverse. I have never seen or heard of any injury to the skin, nor have I seen any ecchymosis from the pressure of the instrument.

In some experiments with Rizzoli's osteoclast, on the adult cadaver, by Dr. E. H. Bradford, of Boston,[1] he states: "The fracture was always sharply transverse, as if cut three quarters of the way through and waving the rest without any splintering."

The reason I do not think that anterior curvatures are suited for osteoclasis is that, if force is applied in a direction from before backward, pressure will have to be made directly over the crest of the tibia; and in many of these cases it is much sharper than in the normal limb, and is not as well covered. If the fracture is made by applying lateral force, much manipulation is necessary to bring the lower fragment forward. It has never worked satisfactorily in my hands. Angular deformities near the epiphysis I have never tried to correct, as it would be necessary to place one of the rings over the epiphysis, and separation of that portion of the bone might occur. In this class of cases I have always performed a

[1] Private note.

linear osteotomy. I have never had an accident of any kind happen after an osteoclasis of the bones of the leg.

I think that, with the above exceptions, all cases of tibial curves should be corrected by osteoclasis.

Accidents.—A case of non-union is reported by Dr. Fifield.[1] It occurred in a girl, five years of age, who presented a congenital distortion of the arms and legs. In August, 1880, osteoclasis was performed on the left tibia and fibula. In October of the same year a similar operation was done on the right leg and fore-arm. The bones of this limb united in a good position in a few weeks, but the left tibia did not unite firmly, and there was considerable projection forward at the seat of fracture. In March, 1881, the bones were again fractured at the point of partial union, and the tendo Achillis divided. The leg was straightened and placed in a plaster-of-Paris splint. In April there was no formation of callus, but by May there was partial union with bowing forward of the tibia. During the next sixteen months she wore a steel brace, but there was no improvement. During the month of June, 1882, it was twice fractured, but with no effect as regards union. In September, 1882, an incision was made down upon the point of fracture; the periosteum was found to be thickened and the ends of the bone sclerosed. A thin, wedge-shaped piece of bone was removed from the extremities of both fragments and the ends of the bones wired together, and in two months firm union was established between the fragments. Porter[2] re-

[1] "Med. News," April 14, 1883, p. 416.

[2] "Boston Med. and Surg. Jour.," April 14, 1879, p. 217.

ports a case of anterior curvature of the tibia. On one limb osteotomy was performed, on the other osteoclasis. Five weeks after the latter operation there was found considerable overlapping of the ends of the bones, and a small fragment was found to be movable at the point of fracture, which later became attached and solid, thus proving that there had been comminution.

The object of osteoclasis is to produce a simple fracture and then to keep the limb, in a fixed bandage, in a corrected position until firm union has been established. With the osteoclast of Rizzoli and Taylor the point of fracture is certainly under the control of the operator, and, with the exception of the two cases mentioned in a previous page, I have never heard of any accident or failure to correct in lateral and antero-lateral curvature.

The result on the bone itself has been determined by Dr. A. T. Cabot,[1] who obtained a specimen from a patient who died four months after the operation. On longitudinal section of the bone, an imperfectly marked transverse line indicated the point of fracture. The medullary cavity was somewhat narrowed, though by no means obliterated. There was a thin layer of spongy bone enveloping the tibia and extending for an inch or an inch and a half above and below the point of fracture.

Cases of curvatures of the tibia suitable for osteoclasis are those of long lateral bends in which there is not any marked anterior deformity. Pure anterior curves I do not think as well suited for the operation. The danger of applying any considerable force

[1] "Boston Med. and Surg. Jour.," 1879, vol. ci, p. 217.

over the crest of the tibia would seem a strong argument against the operation in this class of cases, and a fracture by lateral pressure would require a great amount of manipulation of the bone and disturbance of the soft part. It has seemed to me that a cuneiform osteotomy was the better operation, and really to necessitate less injury to the muscles and tissues about the bone. Dr. E. H. Bradford, of Boston, however, uses the osteoclast for this description of curves, and thinks well of it. That the fracture is not as simple as when the instrument is applied laterally is shown by the comminution in Porter's[1] case. Sharp curvature near the joint should be corrected by a linear osteotomy. The danger of injury to the lower epiphysis of the tibia is great if one of the points of counter-pressure is directly on it.

The same remark applies to sharp curvatures just below the knee joint.

In regard to the age at which osteoclasis should be performed, I think it is a question to be decided by each operator for himself. Fracture of the long bones in children is a trivial affair. The pain after it is not great, and by the following day they are as merry as though nothing had been done. In some cases, while the bones are quite soft, the deformity can be corrected by simply bending the bones with the hands and then putting the limb up in a plaster-of-Paris splint. If restitution can not be accomplished by this means, it must be left to the surgeon to say whether an attempt shall be made to correct the curvature by splints or by an osteoclast. In children over four years of age I think, as a rule, ap-

[1] *Loc. cit.*

paratus is useless. In hospital practice I always fracture as soon as I am satisfied that the bones are moderately hard. I have never met with any return of the deformity after an osteoclasis, and in appropriate cases the correction is perfect.

In 1879[1] an apparatus was presented, at a meeting of the Société de Chirurgie de Paris, for the correction of genu valgum, devised by M. Collin. Its purpose was to produce a separation between the epiphysis and diaphysis at the lower end of the femur, thus substituting instrumental in the place of manual force in Delore's operation. It consisted of two semicircular collars or crutches, to be applied, one to the middle of the thigh and the other to the inferior third of the leg, from their posterior aspect, and separated by a frame movable at right angles to their long axis (*porte-à-faux*) by a lever, by which force is brought to bear upon the knee joint from within outward. This portion is provided with a well-padded plate placed on the inner side of the knee. These two semicircular collars are supported by two iron rods, sliding in a steel groove, in order to adapt them to different limbs. A movable part, worked with a long stem acting as a lever, draws the knee outward, while the two collars indicated above hold the limb firm. In order to prevent rotation of the leg, the patella is held by means of a concave pad, which is set between two uprights and moved by a screw, so as to be raised or lowered at will. The whole apparatus is mounted upon a thick piece of wood which is made very solid (Fig.

[1] "Du genu valgum et de son redressement par l'appareil Collin." Braye, "Thèse de Paris," No. 472, 1880.

45). The power is applied by means of the long lever, which draws the movable portion outward with great force. It has been demonstrated on the cadaver that in all cases the separation takes place invariably be-

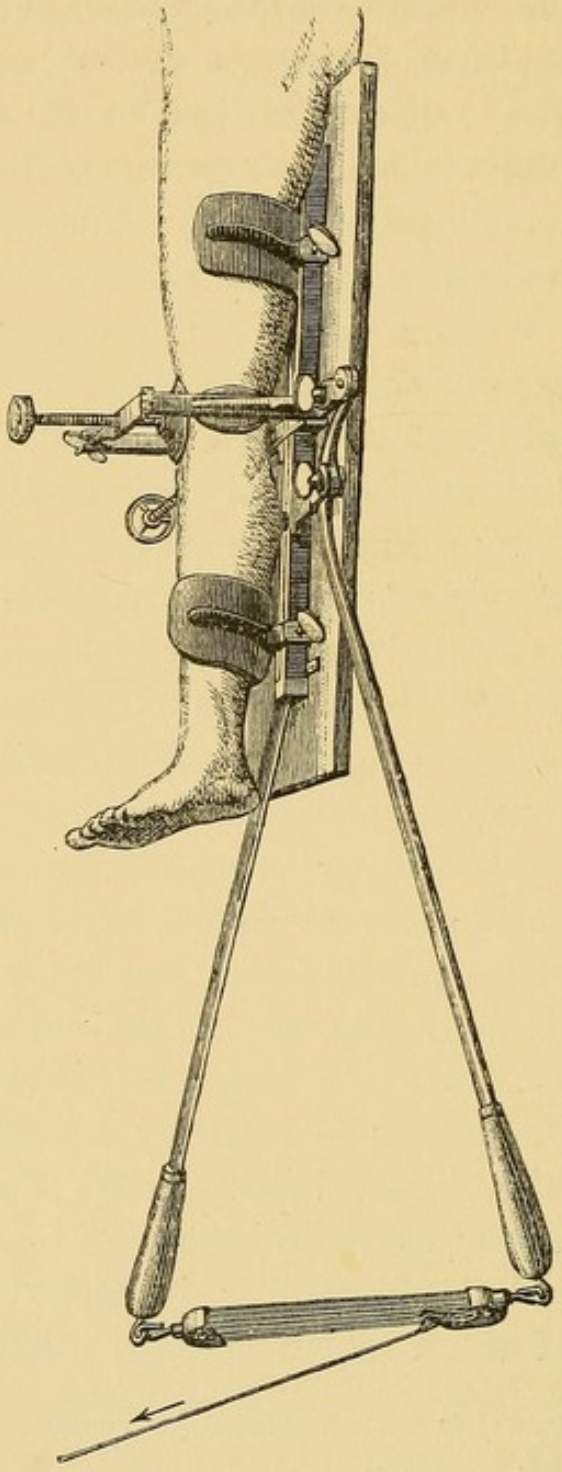


Fig. 45.

tween the epiphysis and diaphysis, without any injury to the ligaments or the joint. In five limbs on which the apparatus was used, in patients varying from six to fifteen years of age, the result was excellent.

In 1882, Robin,[1] of Lyons, exhibited a new osteoclast for fracture of the lower end of the femur. It consists (Fig. 46) of an iron case extending half-way around the thigh, on its anterior aspect, from a point a

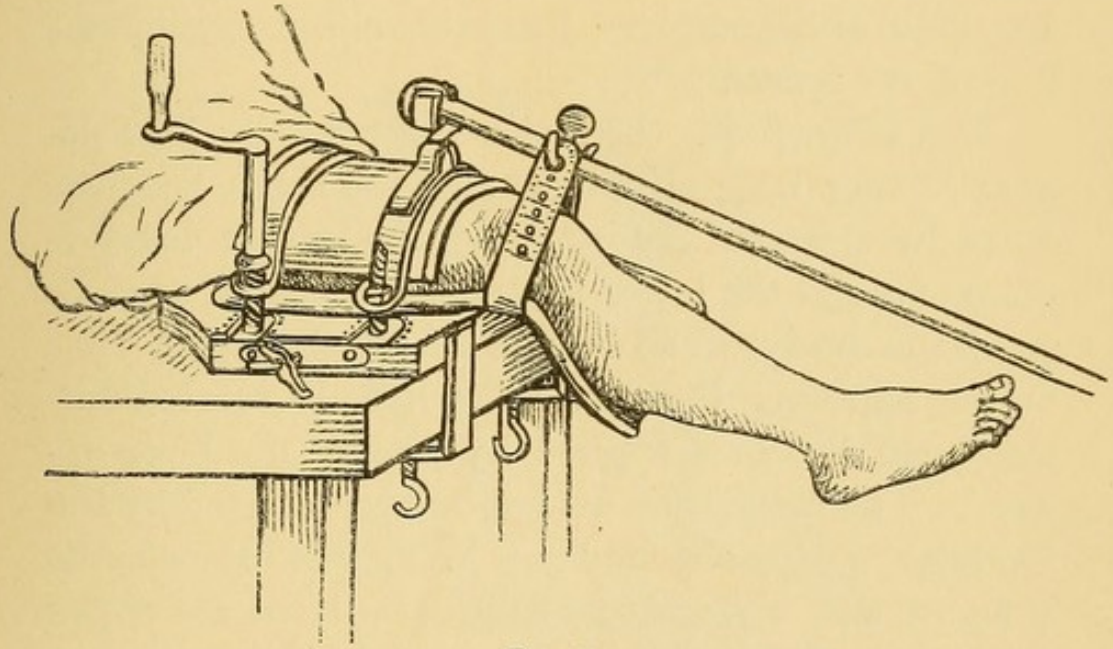


Fig. 46.

short distance above the condyles of the femur upward to the superior third of the thigh. Two steel collars bind this to a piece of heavy plank—the one at its lower, the other at its upper limit. Each collar is fastened to the plank by a nut and screw. This portion of the apparatus holds the femur secure. To the upper or superior portion of the lower collar an upright is securely fastened, having a slot at its

[1] "Lyon méd.," March 26 and April 2,1882.

upper part at right angles to the collar and parallel to the long axis of the limb. Into this slot is fitted one end of a lever, which extends down over the leg. A strong leather strap, large enough to surround the thigh just above the condyles and pass around the lever, completes the apparatus. It is evident, when the osteoclast is adjusted, that the lever will act, when pulled upward, as one of the second order where the weight is between the fulcrum and power. The object is to cause a transverse fracture, either complete or incomplete, just above the epiphyseal line of the femur.

The following is the method of using it: The patient having been etherized, and the thigh fastened down by means of the iron case, the leather band is placed around the lower portion of the thigh so as to grasp the condyles and then pass over the lever. Just before applying the power the limb is rotated outward and the force applied by forcing the lever upward. The vessels and nerves, being protected by the condyles, escape any injury. With this osteoclast it is found that the fracture takes place just above the condyles, and that the correction of the deformity can be readily made. Robin is reported by Delarue[1] to have collected eighty-three cases operated with success. In many the operation was followed by effusion into the knee joint. The time required to obtain firm consolidation was from four to eight weeks. I have had no experience with either of these instruments. Their use has been so limited that but little is really known of their merits in this country. Dr.

[1] "Du redressement du genu valgum." "Thèse de Paris," 1884, No. 184, p. 49.

E. M. Moore, of Rochester, has used this instrument in a case of deformity at the knee joint.

This osteoclast, with slight modifications, has been used to rupture an ankylosed knee joint.

ILLUSTRATIVE CASES.

CASE I.—George Mc., six years of age, admitted into St. Mary's Hospital for children in May, 1882,

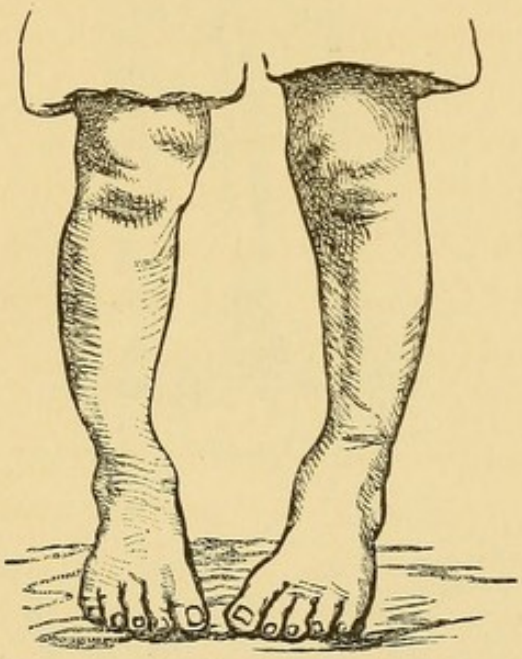


FIG. 47.

with lateral curvature of the bones of both legs of rachitic origin. He is a well-developed boy, and in excellent condition. Fig. 47 is from a photograph taking shortly after admission into the hospital.

May 15, 1882, osteoclasis was performed upon both limbs, the pad of the instrument being placed on the outer aspect of the limb at the point of greatest curvature. After fracture the limbs were put up in plaster-of-Paris bandages in a straight position.

Patient did not complain of much pain after the influence of the ether had passed off, and at no time did his temperature rise above the normal.

June 14th, splint removed and union found to be

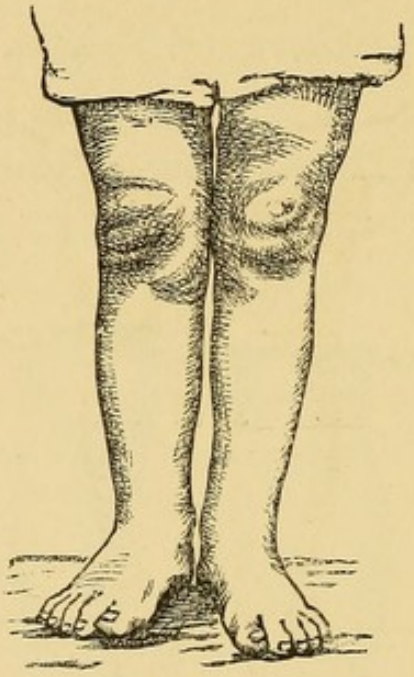


Fig. 48.

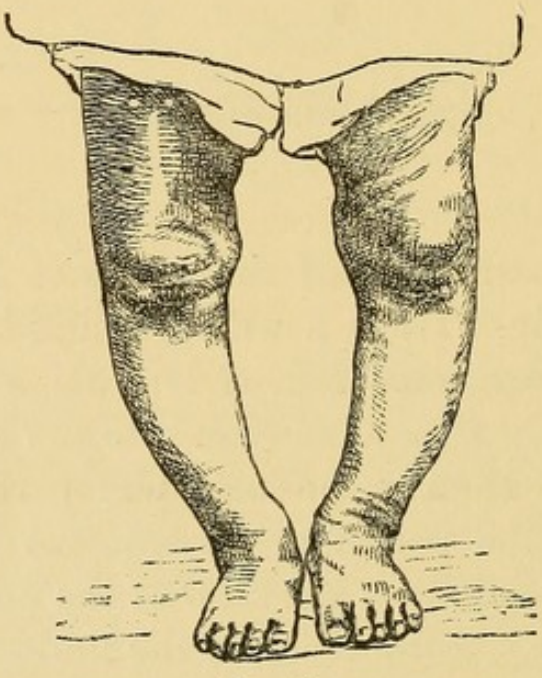


Fig. 49.

firm, and the limb in a good position. He was allowed to get up. Fig. 48 is from a photograph taken at the time of his discharge.

Case II.—Ada R., three years of age, admitted into St. Mary's with rachitic curvature of both

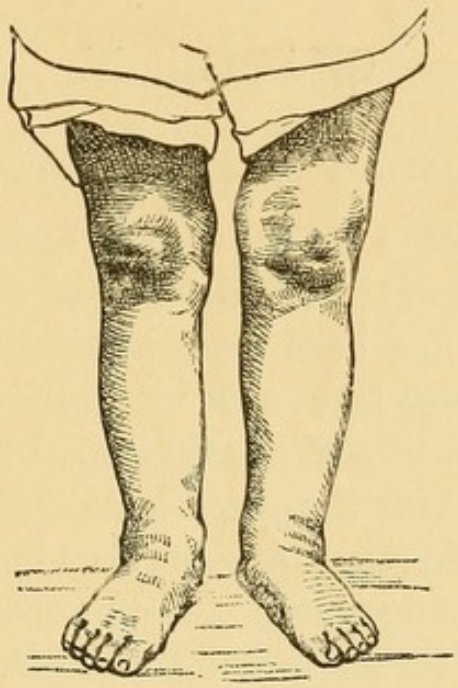


Fig. 50.

legs. She is in good condition, and the bones are quite hard.

Fig. 49 shows her condition at time of admission. Osteoclasis was performed on both limbs. They were put up in a plaster-of-Paris splint in a straight position. They were removed at the end of four weeks.

Fig. 50 is from a photograph at time of discharge.

CHAPTER X.

STATISTICS AFTER OSTEOTOMIES.

My experience in osteotomy and osteoclasis, although not as extensive as that of some European surgeons, yet has been considerable. For the purposes of statistics I have divided all osteotomies into two classes, linear and cuneiform. In my judgment, the bone on which the operation is performed has no influence on the result except that the more superficial the bone the greater is the liability for suppuration to follow, for the reason that there is greater danger of the lips of the wound being separated by extravasation of blood if adequate drainage has not been provided. I have performed seventy-four linear and seventeen cuneiform osteotomies. All the patients on whom these operations were performed recovered with the deformity corrected, except two cases of genu valgum, on which a Reeves's operation was done and in which the condyle could not be detached on account of the relaxed condition of the external lateral ligament.

The following are the cases in which suppuration occurred:

In the first case of linear osteotomy for bow-legs considerable and troublesome suppuration took place

in both limbs, and from the left a small shell of bone was detached from the lower end of the upper fragment. During the operation the anterior tibial artery was divided by the osteotome, which was allowed to project outward beyond the line of the crest of the tibia. I think, moreover, that the operation was not performed properly, and that my osteotomes were too thick; there was not sufficient drainage. In the second, suppuration occurred in one limb, but to a slight degree. The wound was not closed properly, and the compress irritated the tissues of the leg. In the fourth case there was a trace of pus for a day or two, and in one patient a small slough formed under a compress. In the third case of genu valgum after a Macewen's supra-condyloid operation there was a little suppuration in one limb for a few days. In the fifth case there was found, upon the fifteenth day after the operation, a collection of pus extending from the wound up as far as the upper third of the thigh. It was situated between the muscles and the skin, and did not communicate with the bone, as stated on page 114. On removing the small piece of gauze covering the wound, a free discharge of pus took place and emptied the abscess-cavity. The compress was glued to the skin immediately around the wound by blood, and formed a portion of the outer wall of the abscess-cavity. I think that the abscess had its origin in a small piece of adipose or cellular tissue protruding from the lips of the wound; this was irritated by the gauze, and a small quantity of pus formed; it could not escape on account of the firm adhesion of the compress to the skin, and the dried blood on the gauze rendered it stiff and hard. It

forced the lips of the wound apart and, as its quantity increased, the matter burrowed backward and upward. The application of a compress was soon followed by a cure. The temperature in this case did not rise above the normal until the day on which the abscess was discovered, and then only reached 100°. In the ninth case a small collection of pus was found some days after the operation; it gave no trouble, and did not retard convalescence. The cause of the abscess may have been an improper handling of the limb.

In the twelfth case quite an extensive collection of pus occurred in the left limb, for which no cause can be assigned; it did not communicate with the bone, and was easily controlled.

I have therefore had eight cases of suppuration in seventy-four linear osteotomies.

CUNEIFORM SECTIONS.

In the first six limbs operated upon, suppuration took place in all to a considerable extent, necessitating frequent dressings. The cause of this, I am satisfied, was an improper management of the wounds. The pus in all these cases was in contact with the bone. In three limbs there was a slight necrosis, but all eventually made a good recovery, with the deformity corrected.

Since I have managed the wound differently there has been no complication, except in one case at present under treatment. It occurred in a boy, eight years of age, with a marked anterior curvature of both tibiæ, and on whom I performed a cuneiform osteotomy on both limbs.

For the first two days he was continually in motion, twisting his limbs in every direction, and which it was impossible to control. On the third day both legs were greatly swollen, and suppuration followed, necessitating frequent dressings. At the present time (four weeks after the operation) he is doing well. I think that in this case suppuration was due to motion between the fragments of the bone.

I have lost two patients after an osteotomy, one dying from diphtheria, the other from meningitis. At the time of death firm union existed at the point of operation. The fatal issue in these cases was in no way traceable to the operation. I have performed osteoclasis upon thirty-four limbs for the correction of lateral curvature of the tibia. In all recovery took place without any complication, the deformity being relieved.

I have been able to collect the result in fifteen hundred and ten (1,510) cases of osteotomy for the correction of deformities at the hip joint, for genu valgum and tibial curvature. Section for deformities of the knee joint and operations for vicious union after fractures are not included, for the reason that these sections do not strictly belong to the class of deformities considered in this volume. The labor necessary to collect such statistics, to be of any value, would trespass too much on my time, and would delay the appearance of this volume, which has already taken a much longer time than I had anticipated in its preparation. Of the total number of osteotomies, fourteen hundred and forty-eight (1,448) were linear and sixty-two (62) cuneiform. Of the former, fifteen, (15) died, in ninety-two (92) suppuration is reported

to have occurred, and in seventeen (17) there was some necrosis—a mortality of ·010 per cent.

Of cuneiform osteotomies, in seventeen suppuration is reported, and five died—a mortality of ·96 per cent.

Taking the whole number of operations, there was a mortality of ·0132 per cent. There have, no doubt, been other fatal cases, but no record has been made of the fact, nor do these figures probably give a fair representation of the number of operations that have been performed.

Deformities of other bones have been corrected by an osteotomy, but the number of the operations are few. Muralt[1] and Schoepff[2] have divided the humerus for the correction of deformity of this bone after fracture. Walton[3] operated upon two cases of ankylosis of the elbow joint in a straight line by dividing the humerus. Barwell[4] mentions another case. Mears[5] made a section of the humerus near the joint in a case of old dislocation. Gardeil and Guterbock,[6] and Hill[7] have divided the radius for vicious union after fracture. In all of these cases a good result was obtained.

Taking into consideration the many accidents, the want of experience as to the class of cases suitable for an osteotomy, the faulty methods in operating, and wound management, the results have been excellent. If the earlier operations were left out, the mortality would be reduced to almost zero.

[1] "Campenon," *loc. cit.* [2] "Campenon," *loc. cit.*
[3] "Lancet," April 3, 1880, p. 226.
[4] "Treatise on Disease of Joints," 2d ed., p. 565.
[5] "Trans. Am. Surg. Assoc.," vol. i, 1881–'83, p. 115.
[6] "Campenon," *loc. cit.*. [7] "Lancet," 1872, vol. ii, p. 153.

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