

## Lecture.

THE BONES OF THE LEG CONSIDERED AS ONE APPARATUS.<sup>1</sup>

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Now that we have studied the tibia and fibula in the usual way you are no doubt prepared to admit that the fibula is a most difficult and confusing bone. Indeed, I consider it the hardest in the body, but I wish to show you that the trouble comes from studying it alone instead of in its natural connections. In works on anatomy you find after the description of the bones of the spine, the skull, the thorax and the pelvis respectively, chapters on the spine, the skull etc., as a whole, but this view of the tibia and fibula is not given. I invite your attention, therefore, to a chapter which anatomists have apparently forgotten to write. You will find, I hope, that your ideas of the bones of the leg will be simplified, and that the fibula in particular will have lost half its terrors. Unlike the radius and the ulna, the bones of the leg are always in very nearly the same relative position. They are parts of one apparatus for supporting the weight of the body, forming the socket of the ankle-joint and giving attachment to muscles. The weight-bearing is done almost wholly by the tibia. Both bones have a share in forming the ankle-joint and in certain changes of position of the foot there is some slight motion between them. When the foot is extended,<sup>2</sup> that is, bent upwards towards the shin, the broadest part of the articular surface of the astragalus is brought between the malleoli, and the fibula gives a little. If the socket were wide enough to admit the broadest part of the astragalus without this giving, the latter bone would in most positions be without adequate lateral support. Still the amount of motion is very slight indeed. Very powerful muscles arise from the bones of the leg and the apparatus is broadened at the upper part to give them more room in a way consistent with the least possible increase of weight and the greatest elasticity. If this expansion were of bone there would be a very unnecessary increase of weight, as all that is needed besides the tibia, which is in the line of pressure, is a smaller bar at some distance from it and a membrane between them from which muscle can arise as well as from bone. The fibula is very elastic, and is undoubtedly subjected to much strain from muscular action, especially in sudden efforts, and it is of great advantage that it should be attached to the tibia by a joint to break the shock rather than be of the same piece. If it were not so arranged, fractures of the fibula alone would be much more frequent than they are. Moreover, it is possible to conceive that if the bones were continuous at their ends, the place of the membrane might have been taken by bone so thin as to add very little to the weight, but it is clear that the elasticity of the structure would have been lost or at least much lessened.

When the bones are together the breadth of the upper half of the structure, its narrowing to about the junction of the lower and middle thirds, and the subsequent moderate expansion for the ankle are all very evident.

<sup>1</sup> A lecture delivered at the Harvard Medical School, November 14, 1887, rewritten and added to.

<sup>2</sup> There is much confusion in the use of the terms flexion and extension as applied to the foot. It seems to me simplest to consider flexion the result of the action of the flexors and extension that of the extensors.

Professor Humphry has pointed out the advantage of the narrowing to reduce the weight near the end of the limb that it may be swung the more easily, and also the need of a certain enlargement of the bones lower down to form the socket for the ankle. The amount of the narrowing varies considerably. It is very much less than usual in the bones from which Figures 4, 5 and 6 are taken. The junction of the middle and lower thirds is well known to be a weak point in the leg and various explanations of the fact have been given. It seems sufficient to say that at this point not only the circumference of the chief bone is at its smallest, but that the girth of the whole bony framework of the leg is smallest too. It is, moreover, as has been pointed out, the place at which the upper prismatic part of the tibia joins the lower cylindrical one.

By the study of these bones on a ligamentous preparation, we get at once a correct idea of another very important feature, namely, the want of parallelism between the transverse axes of the knee and ankle, or in other words the twisting of the bones of the leg by which the foot is turned outwards. If the bones lie on a table, the upper end rests on the internal tuberosity of the tibia and on the head of the fibula, except in some cases, when the latter bone bends so much backwards that a part of the shaft instead of the head is the point of support. In either case the anterior border of the top of the tibia is very nearly horizontal, the shortness of the outer tuberosity being made up for by the backward projection of the fibula. Turning to the lower end we see that it rests either on the outer malleolus or on the outer border of the tibia and that the inner malleolus is in the air. The transverse axis of the joint runs outward and downward. The variation of the degree of torsion is considerable. Mikulicz measured it on one hundred and twenty tibiae and found that the angle formed by the axis of the knee with that of the ankle ranged from 0° to 48°. The latter was, however, a very extreme case, and but very few approached it. In about two-thirds of the cases it ranged from 5° to 20°. This, to be sure, is easily seen on the tibia alone, but it is much more striking when the bones are united. Another idea which we gain from studying the bones lying on the table in this position, is that the general course of the fibula is not far from a straight one, while the inner posterior border of the tibia describes a great curve from the table. I shall return to this point when we come to the tibia in the living.

Let us now begin the description of the two bones as one piece. You will understand that it is not my intention to repeat the description of points that have been sufficiently dwelt on in the usual account of the bones, but to give you the outlines of the composite framework. I therefore say nothing of the internal structure of the bones and make no effort to give a complete list of the muscular attachments.

We find an upper and a lower end bounding the middle portion. The upper end is the same as that of the tibia plus the head of the fibula, which is situated far back on the outer aspect, and which is below the knee-joint. I have no occasion, therefore, to repeat the description of the upper end of the specimen. The lower end forms the socket for the ankle. The roof of the socket is broader in front than behind, and slightly concave from before backwards. There is a slight antero-posterior elevation in this surface which

is more easily recognized by the touch than by sight. I would call your attention to the fact that slight changes in the surface of bones are best studied by the finger. Notice that the inner surfaces of the malleoli incline away from one another as they descend. This slant is greater in the short inner malleolus than in the longer outer one which sometimes forms but little more than a right angle with the lower articular end of the tibia.

When we look at the bones lying on the table it is easy to see that the inner malleolus is anterior to the outer. This is due to the twisting of the bones already referred to, for if we grasp the bones by the middle and consider only their lower ends, this does not appear. The outer malleolus is also decidedly longer than the inner. There is a little fold of synovial membrane which continues the ankle-joint a short distance between the bones above the socket. Just above this they are firmly bound together by the interosseous ligament.

We now come to what we may call the shaft of the structure, which consists of the shafts of the two bones and the interosseous membrane. We recognize three borders and three surfaces.<sup>3</sup>

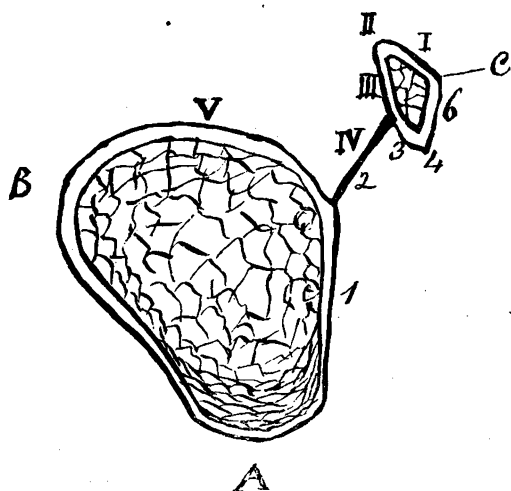


FIG. 1. About two inches below the upper surface.

The *anterior border A* is the crest of the tibia which, beginning at the tubercle, ends at the front of the inner malleolus. Its course is sinuous, the upper part having a slight convexity inwards, the lower, a stronger convexity outwards. In Figure 1, a little below the tubercle, this border is still very thick; at the middle of the leg, it is sharp; and near the ankle, it is not always to be recognized in a cross-section.

The *internal border B* is that of the tibia which begins at the inner tuberosity and ends at the back of the inner malleolus. Of the cross-sections the one at the middle of the leg is the only one which shows it at all clearly.

The *external border C* is the one known as the external border of the fibula (Quain) or the posterior border (Gray)<sup>4</sup> running from the styloid process to the back of the malleolus. The cross-sections show that this is at the outer part of the fibula above and at the posterior below.

<sup>3</sup> The description should be followed on the figures of the cross-sections, as well as on the views of the surface. The former were made from a ligamentous preparation imbedded in plaster so that the proper relations might be preserved. The figures are of the natural size.

<sup>4</sup> Postero-external. Gray. Last edition.

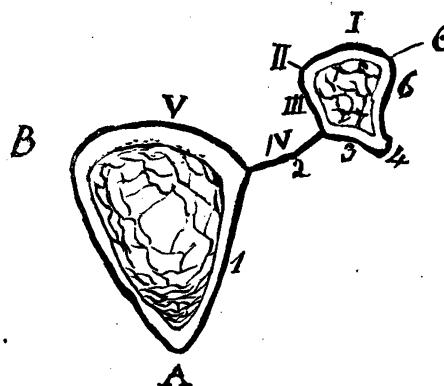


FIG. 2. Near the middle. Though the lines on the surface are well marked, these bones are probably from an old person as the tibia has much less solid bone below the crest than usual.

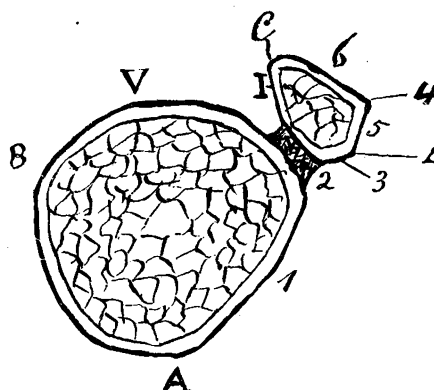


FIG. 3. About one inch above the lower surface of the tibia. The interosseous ligament is seen in place of the membrane.

The *internal surface* is bounded by the anterior, and internal borders A and B. It is seen much fore-shortened in Figures 4 and 6. It is the internal subcutaneous surface of the tibia. Passing the fingers down this surface one perceives that it is slightly convex in the upper part, slightly concave in the lower.

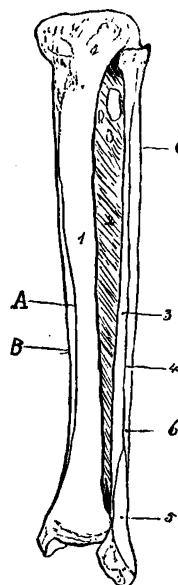


FIG. 4.

Figure 4 gives the anterior and outer aspect.

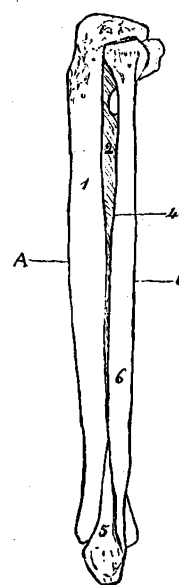


FIG. 5.

Figure 5 gives the outer aspect.

The *antero-external surface* is bounded by the anterior and external borders, A and C. It is much broader above than below, owing to the greater size of the upper part of the tibia and the greater separation of the bones. Its upper portion looks obliquely forwards and outwards but its lower is continued round to the back of the fibula. It presents the following features from within outward (which are marked by corresponding Arabic numerals on the figures): (1) A smooth surface formed by the tibia, the upper two-thirds of which looking outwards give origin to the *tibialis anticus*. Just below the inner tuberosity of the tibia, the inner part of the origin of the *extensor communis* is attached to it. The lower third of this surface twists forwards on to the front of the tibia, where it is covered by the *extensor tendons*. (2) The *interosseous membrane* forms the floor of a gutter which is shallow and broad above, deep and narrow below. It has one or more openings near its upper angle, of varying size and shape for the passage of vessels and nerves. The three chief extensors all arise in part from the membrane. (3) A narrow portion of the fibula looks inward, forming the outer wall of the gutter and giving partial origin to the common extensor and to that of the great toe. This surface is so perfectly clear when the bones are in place and united by membrane, that it is hard to realize how perplexing it may be on the separated fibula, especially if it be a poorly-marked one. (4) Next comes a ridge, the so-called anterior border of the fibula. It begins near the head of the bone, but at first it is often indistinct. It is very sharp about the middle of the leg. It bifurcates some three inches above the tip of the outer malleolus, one line going to the front, the other to the back of that structure and inclosing (5) a triangular subcutaneous surface looking outward above the outer ankle. (6) The last feature is a surface for the *peroneus longus*, and *peroneus brevis*, which beginning at the outer side of the fibula twists to its posterior aspect so that the tendons of these muscles pass behind the malleolus. This surface is strikingly smooth and its spiral course very evident. The two greater peronei are enclosed in a fibrous chamber by fasciæ passing inwards from the deep fascia of the leg to the anterior ridge of the fibula (4) and to the external border of the combined structures (C).

The *posterior surface*. Continuing our course round the back of the leg, we meet from without, inward after passing the external border (C), the following features (marked on the figures with Roman numerals): I, a surface on the fibula looking above, backwards; below, inwards. In its lower quarter it reaches the *interosseous membrane*. From its upper portion, arises the outer part of the *soleus* and from its middle portion (more than its middle third) the *flexor longus pollicis*. II, a ridge called the oblique line of the fibula (Gray),<sup>6</sup> the internal border (Quain) starts from the back and inner aspect of the head of the fibula and twisting inwards and forwards strikes the *interosseous membrane* somewhat above the lower quarter of the leg. Above this point, another surface, III, looking inward, comes between the ridge and the *interosseous membrane*, IV. This membrane is at the bottom of a deeper depression than in front. It gives origin to only one muscle, the *tibialis posticus*, which encroaches also on the bones on either side. It ends below in a sharp angle between the bones just above

the *interosseous ligament*, the surfaces for the attachment of which are not seen when the bones are together. Next comes V, the posterior surface of the tibia. In the upper part of this the oblique line, VI, running downwards and inwards from the head of the fibula, marks off the popliteal surface, and gives origin to a part of the *soleus*. At about the juncture of the first and second quarters, or rather lower, is the nutrient foramen, the largest in the body, which is directed downwards. If the parts are very vascular, as the result of inflammation, the nutrient artery may give trouble after amputation. The foramen is sometimes very close to the *interosseous membrane*, sometimes half-an-inch from it. The much smaller canal for the fibula is on one of the posterior surfaces of the bone; most frequently on that marked I. In the forearm the nutrient foramina are found, also on the flexor surface of the bones, but there, they run towards the elbow and here they run from the knee. A much less distinct line is seen running nearly vertically about the middle of the bone, which separates a broader inner portion, from which arises the *flexor communis*, from a narrower outer one, beside the membrane which gives origin to the inner part of the *tibialis posticus*.

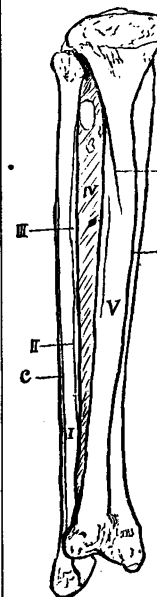


FIG. 6. Posterior and inner aspect.

After this detailed description of the ridges and surfaces of the bones, we return to the study of the twists of the bones and we shall find it a less simple problem than is generally supposed. We saw at the beginning, that the lower part of the skeleton of the limb is twisted outward to allow the foot to assume its characteristic, human position. If we follow the ridges of the fibula, excepting that for the *interosseous membrane*, we find them pursuing a corresponding course. The surface for the *peronei* (6), shows this feature strikingly, and the one just beyond it on the posterior aspect (I), hardly less well. Now as the axes of the ankle-joint is determined chiefly by the tibia and as it is undoubtedly turned outward we should naturally expect to find the borders and surfaces of the tibia, turned the same way, but we do not find such to be the case. On the contrary, we find the anterior crest of the tibia twisting downwards and inward to the inner malleolus, and the two surfaces which it separates, to take a similar course. The twist of the posterior surface of the tibia is more difficult to analyze. It would seem as if, at least, the greater number of the surfaces of both bones twist as they descend away from an imaginary line between them.

It is interesting and important to know how much of the bones can be felt during life. The whole of the front and sides of the head of the tibia are easily made out, but it is deeply placed behind and obscured by the hamstrings and the *gastrocnemius*. The tubercle is very prominent in front, just at the insertion of the ligament of the patella. It is worth knowing that the tubercle is a part of the superior epiphysis of the tibia, which descends further in front than elsewhere. At the sides its line of union coincides with the lower border of the tuberosities. It

<sup>6</sup> Postero-internal. Gray. Last edition.

includes, therefore, the articular surface for the head of the fibula and the upper anterior aspect of the latter, indicates pretty nearly the position of the line. The crest of the tibia is easily traced downwards from the tubercle. The finger that follows it reaches the inner malleolus. In muscular legs the tibialis anticus, projects somewhat beyond it, and this together with the dense fascia covering the extensors that springs from the crest tends to make it a far less prominent feature in the living than one would expect from the skeleton. In athletes, antique-statues and outline-drawings, there is a striking curved line in the leg, which the ignorant might easily mistake for this ridge, but which is caused by the internal border of the tibia. It is well shown in both legs, but especially the left one, of this outline from Flaxman's illustrations of the Iliad, representing one of two giants holding Mars captive. Notice that the line begins high up under the inner tuberosity of the tibia, and ends at the back of the inner ankle, corresponding perfectly to the internal border (B). One of the reasons why some are deceived is that they expect this border to be at the inner side of the leg, in the flesh as it is in the bones, forgetting that the great muscles of the calf, overlap it considerably and fill in a good part of the outline of the leg, even when seen from the front, as in this figure. This border curves forwards as well as outwards, so that this feature can be seen not only from the front but from the side. The subcutaneous internal surface of the tibia can be felt throughout.

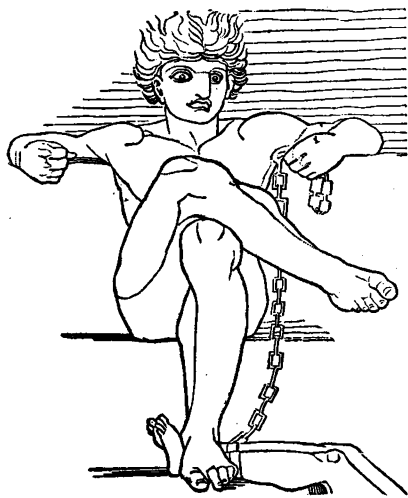


FIG. 7. "Otus and Ephialtes held the chain."

The anterior surface of the tibia below the origin of the tibialis anticus is easily felt just above the ankle, though it is obscured by the extensor tendons passing over it. The head of the fibula is to be felt far back on the outer aspect of the leg. Very soon the peronei cover the shaft with a thick pad so that, although the position of the bone can be made out, its outlines are concealed till we get down to the triangular, subcutaneous surface, beginning some three or four inches above the ankle. The greater length, the more posterior position of the outer malleolus as well as the difference in shape from the inner one are easily recognized.

— The Court of Appeals of St. Louis has refused to incorporate the "Institute of Christian Science."

## Original Articles.

### LEAD-POISONING AS A CAUSE OF MUSCULAR INCO-ORDINATION (PSEUDO TABES).<sup>1</sup>

BY JAMES J. PUTNAM, M.D.

It is well known that a number of cases have been described within the past few years, usually presenting a greater or less number of the symptoms which we are in the habit of referring to multiple peripheral neuritis, such as objective and subjective sensory disorders of a variety of kinds, and muscular wasting, with diminution of electrical irritability, but characterized above all by inco-ordination in the use of the muscles of the extremities.

The analysis of these cases shows that this inco-ordination may occur without many of the other symptoms of neuritis, just as, in other cases of the disease, the cutaneous sensory disorders may predominate, or even occur alone, or as paralysis may come on, and after lasting for a short time, disappear, without leading to muscular atrophy.

To this group of cases the name of pseudo tabes has been given, and although this name is not really a suitable one for many of the examples reported—those, for example, where the knee-jerk is exaggerated instead of being diminished—yet it is of temporary value as indicating the possibility of confounding cases of this kind with true locomotor ataxia, a mistake which has, in fact, no doubt often been committed.

In such cases as those which form the subject of this paper, there is a true impairment on the part of the patient's ability to co-ordinate their movements accurately, probably due to a loss of the impression coming from their muscles; but another class of cases has also been included under this same name of pseudo tabes, where there is no true inco-ordination, but a disorder of movement due to loss of power on the part of certain groups of muscles. In these cases the gait of the affected patient is of a character that has been likened by Professor Charcot to the movement of a high-stepping horse, because, in consequence of the paralysis or weakness of the extensors of the foot, the toe drops when the leg is lifted, and the knee has consequently to be raised unnaturally high in order to clear the foot from the ground. Furthermore, these patients, on account of their muscular weakness, often walk with an uncertain and somewhat straddling gait.

Of this latter group of cases I do not intend to speak further, although they are doubtless related, pathologically, in many respects, to those where true muscular inco-ordination is present.

All that is absolutely known, so far as I am aware, of the pathology of pseudo tabes of neuritic origin is furnished by the results of three autopsies, two of them reported by Déjérine,<sup>2</sup> and the third by Dreschfeld.<sup>3</sup> In these three cases the disease was presumably of alcoholic origin.

The clinical histories agree in all essential particulars with the clinical pictures already indicated. The central nervous system was found practically unchanged in all, whereas there were marked changes in the peripheral nerves.

The microscopic examinations in the two cases re-

<sup>1</sup> Read before the Boston Society for Medical Development, Nov. 30, 1887.

<sup>2</sup> Arch. de Phys., 1884, Nervo Tabes Périphérique.

<sup>3</sup> Brain, 1885, Vol. VIII, p. 433.