ON THE LATERAL MOVEMENTS

OF THE FOOT.

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In most modern systematic works on Anatomy a statement is made to the effect that, at the ankle joint, the motions are restricted to flexion and extension, and that, if lateral motion takes place at all, it is only to a very limited extent. It is further added, that the lateral movements of the foot, those of abduction and adduction, as they are termed, are performed at the transverse articulation in the centre of the Tarsus formed by the connection between the five anterior Tarsal bones in front and the two posterior behind. This idea, which I shall endeavour to show, is a mistaken one seems to have arisen from confining examinations mainly to dissection of the joint in the dead without adverting to the appearances that may be observed in the living, or to the circumstance that the motions of the ankle take place under two very different conditions according as it has or has not to support the weight of the body. The outline also of the articular surfaces, especially that of the astragalus, bearing as it does a resemblance to true ginglymoid joints where motion in one plane only is admissible, has doubtless contributed to foster this opinion, for it has been too often the case in Anatomy that conclusions as to the function of organs are drawn from analogy in place of from direct observation.

The analogy indeed between the ankle and such an articulation as the elbow is more apparent than real, as an attentive examination of the contour of the former joint will readily show. The upper aspect of the articular surface of the astragalus is markedly convex, and presents two elevations laterally with an intervening hollow, thus making an approximation to the appearance presented by the the trochlea of the femur or humerus. These lateral elevations are most marked anteriorly and become fainter as we trace them backwards, until at the posterior part they disappear entirely, leaving a uniformly rounded surface. This portion of the astragalus is by no means of the same breadth throughout, being widest in front, and gradually narrowing backwards. This arrangement is caused by the want of parallelism of the two sides which articulate with the two malleoli, and which are placed so obliquely with respect to each other that their planes if produced would meet about the extremity of the heel. An important difference is also observable in these two sides. The internal is vertical, flat, and adjusted for articulation only at its upper and fore part. The external, on the other hand, is rounded, convex, and has an articulating surface occupying nearly the whole of its extent. The articular surface of the lower part of the tibia corresponds with that towards the *fore* part of the astragalus, being arranged into a general hollow having two depressions on either side with an intervening ridge. It is to be remarked, however, that the antero-posterior diameter of the tibia at this part is much less than the corresponding measurement of the articular surface of the astragalus, and also that the arrangement of the ligaments is such that the former bone can be made to coincide either with the fore or back part of the latter. This has an important reference to the lateral motions of the foot.

But before pointing out how these are effected, it may be necessary to show that they do not take place, as usually stated, at the articulation of the astragalus and caleancum behind with the scaphoid and cuboid in front. Were this the case these lateral motions would be effected without movement of the heel, and would still be performed although the ankle joint and heel be fixed. But let this be tried ;—grasp firmly the lower part of the leg, so as to prevent deception from motion of the articulations above, and then fix the ankle joint by seizing the heel, and it will be found that no effort will then produce the motions of abduction and adduction. Again a little attention will show that in these movements the toes and the heel describe arcs of circles in opposite directions, the foot moving as it were on a pivot through the ankle joint—that is, in adduction, when the toes are pointed inwards, the heel is turned outwards, and *vice versa* in abduction. This circumstance appears to have been overlooked, for the movement of the heel is but slight, while that of the toes is extensive, the former from its proximity to the centre of motion describing an arc of a small circle, while the latter describe a curve whose radius is equal to the distance between the ankle joint and the toes. From this it appears perfectly clear that these lateral motions of the foot take place at the ankle joint and nowhere else.

In investigating these movements, the following circumstances especially attract notice :—

1st. The foot does not preserve the horizontal plane.

2nd. The two motions are not equally extensive.

3rd. The position of the foot alters materially the extent to which they can be carried.

1st. The foot does not preserve the horizontal plane. In the motion inwards the foot is twisted so that the inner edge is turned somewhat upwards, the outer edge being directed towards the ground. In the outward motion again but very little if any twist is observable, the foot remaining nearly horizontal.

2nd. The two motions are not equally extensive. The motion inwards or adduction is much more extensive than the opposite one. It may be carried to the extent of throwing the foot obliquely across the instep and foot of the opposite side, and making an angle of from 40° to 45° with a horizontal line drawn at right angles to the tibia (which may be regarded as the regular position of the foot) while the outward motion, or abduction, cannot be carried farther than to place the foot at an angle of 20° with the same line. In estimating the extent of these, care must be taken not to confound the movements of the foot alone with its motions as a part of the lower extremity. The external direction so usually given to the toes during walking is caused not by any motion of the foot itself on the leg, but by rotation outwards at the hip joint.

3rd. The position of the foot alters materially the extent to which they can be carried. These motions are most extensive when the foot is extended, they become somewhat restricted as the foot is bent, and when the weight of the body is thrown upon the foot they are obliterated. This has evidently reference to the security of the erect posture, which would have been endangered had lateral motion, either at the knee or ankle been possible while the weight of the body was being supported by these joints. As already stated, changes in the direction of the foot, while the body is erect, are effected by the movement of the lower extremity as a whole at the hip joint, the foot under these circumstances invariably remaining at right angles to the tibia. Recurring to the arrangement presented by the interior of the articulation, but little difficulty presents itself in explaining how lateral motion should be possible in one position and not in another. When the body is erect and its weight rests upon the ankle, the tibia is supported upon the fore part of the articular surface of the astragalus (which is the widest portion) and all parts of the articulation are pressed firmly together by the superincumbent weight. In this case the astragalus completely fills the space between the two malleoli, which grasp it closely on either side, while the tibia pressess down upon it from above, thus rendering motion save in the vertical plane impossible. This state of parts reaches an extreme when the body is raised upon the toes (as in walking &c.), for then the bones above are forced by the weight above upon the widening fore part of the astragalus, which is thus literally wedged between the malleoli, these processes descending by the side of that bone like bars to prevent its being turned or twisted in any way. A glance at the act of walking will show that it is precisely at this period that lateral motion would have been most unsafe as threatening to throw the body over one or other side of the foot. When, however, the foot is freed from the superincumbent weight by the support of the body being transferred to some other part, then the foot by its own weight passes downwards and outwards separating itself from the tibia, and leaving an interval in the joint in which a rotatory movement of the astragalus may take place. It may be urged that the weight of the foot will be counterbalanced by atmospheric pressure, but I believe this will be counteracted by the synovial fluid which I have observed to be present in the ankle to a much larger extent than in most other articulations, and that so uniformly that I cannot consider the appearance either abnormal or *post mortem*. That an interval between the astragalus and tibia does occur during the dependent position of the foot is seen readily on dissection, and that it also occurs during life the following simple experiment will show. Let a thin slip of wood or ivory or any similar material be firmly fixed in a horizontal position in the hollow of the sole of (say the) right foot so as to receive as little pressure as possible when the person is standing, and sufficiently long to project an inch or two on each side of the foot. Let the body now (in the erect posture) be made to rest its whole weight on that foot, and while so placed let the vertical distance between the slip of wood and the head of the fibula be measured. Let the weight of the body be then transferred to the other foot and the right foot slightly raised from the ground so as to allow its weight to act (still, however, keeping it horizontal, which is easily done by observing the slip of wood) and let the same distance be now measured. It will be found to have increased considerably.*

When the foot is extended, the tibia corresponds with the narrow posterior extremity of the astragalus, and then the space between the two malleoli, available for rotatory motion of the astragalus, is still farther increased. This corresponds with what actual observation shows, that it is in this position of the foot that these movements are most extensive. They seem to take place chiefly by the rounded outer surface of the articular portion of the astragalus gliding over the outer malleolus. The motion of this surface of the astragalus can be distinctly felt during adduction by pressing firmly in front of the outer malleolus, and outside the extensor tendons of the toes. It would appear that these two lateral motions do not go to the full extent that the contour of the bones would allow; they seem to be checked by the anterior and posterior peroneo-tarsal ligaments, the former of which appears to limit adduction and the latter abduction; and such is probably the

* *Note.*—My own observations show an increase to the extent of 0·8 inch, but it will probably be found to vary in different persons. Part of this may certainly be owing to compression of the soft parts of the sole, and part to the approximation of the tarsal bones, but I have no doubt but that the greater part is due to the change in position of the astragalus and tibia.

reason for the arrangement of the ligaments in that particular manner. The principal muscle employed in adduction is the tibialis anticus, and it is to its oblique action that the turning upwards of the inner edge of the foot during that motion is due. Its antagonists are the peronei, more especially the peroneus longus.

From this view of the movements of the ankle it will be seen that it is not to be set down as an example of ginglymus or hinge-joint, if to that term we are to attach the idea of a joint where motion in but one plane is permitted. It must be remarked, however, that of the larger articulations of the extremities, no two are precisely alike, so much so, that in place of being divided into groups, they naturally arrange themselves into a series of which the elbow will occupy the one extreme and the shoulder-joint the other. Such a series would be arranged thus;—1. Elbow, where motion is entirely restricted to a single plane. 2. Knee, where in addition, a slight degree of lateral or rotatory motion takes place when the joint is flexed. 3 Ankle, where though motion in a vertical plane is the principal, yet motion in a horizontal plane does occur. 4. Wrist, where motions in two planes are nearly equal in amount. 5. Hip, where to the rectilineal motions are added rotatory ones, but the extent of each considerably limited by the depth of the articulations; and 6. Shoulder, where the same movements occur, but much more extensively, the limit to these being produced by the arrangement of the ligaments, and not by the contour of the bones.