ART. XXIII.—*Die Physiologie des Hüftgelenkes in ihrer Beziehung zur Lehre von der Coxarthrocace*. Von Dr. B. GADECHENS, pract. Ärzte in Hamburg.
The Physiology of the Hip Joint, considered in Relation to the Doctrines of Hip Joint Disease. By Dr. B. GADECHENS, of Hamburg.

[Translated from the *Zeitschrift für die Gesamte Medicin*. By S. LENOX L. BIGGER, M.B., L.R.C.S.I.]

No very deep knowledge of the doctrines hitherto entertained with regard to diseases of the hip joint is requisite, to convince that they are far from having arrived at the grade necessary to an accurate science; although much has been done to elucidate them, both in our own and in former times, by the most distinguished practitioners, still they are capable of being shaken in their fundamental principles by every severe attack.

The systematic representations of Rust had deservedly obtained the approbation of the medical profession on account of their exhibiting the phenomenon, how under a deceitful exterior, internal disease might be concealed.

English surgeons also (Falconer, Crowther, and Brodie, had with their usual practical sharp-sightedness, got rid of many diagnostic difficulties, and by their pathologico-anatomical examinations, explained more clearly the seat of the lesion and the morbid products during the progress of the disease. Still much remained to be cleared up and unriddled by Fricke's laudable researches, to which our gratitude is due, because they have freed those dogmas from the fetters of authority, and have first excited serious doubts on the correctness of former views and representations.

We cannot wonder that Fricke did not succeed in banishing all obscurity from this his self-chosen path, or in reconciling what is contradictory in his observations to the observations of

his predecessors, since we learned the valuable discovery of Edward Weber, of the hitherto totally disregarded effect of atmospheric pressure on the hip joint. In vain might the surgeon exhaust his talents in attempts at explanation, so long as a physiological problem of such consequence was withheld from his eyes. But by this discovery the way is opened, and the path indicated, by which we may enter on a territory from which we were hitherto partially excluded. Time will shew, if we shall make a proper use of the clue which Physiology has presented to our hands, from the cornucopia of her newest discoveries.

For this reason we have been induced to give a fragmentary description of the influence which the discovery of Weber has had on some striking points of the pathology of the hip joint. With justice may it be said, that with the discovery of Weber, a new and fortunate era commenced for the doctrines of hip joint disease. Weber proved by simple and convincing experiments, that it was not the muscles and ligaments, as was formerly supposed, which preserved the head of the femur in contact with the acetabulum, but that the acetabulum being closed by the head of the bone in an air tight manner, the femur was held suspended by the atmospheric pressure, just in the same manner as the sucker is in a syringe, the anterior opening of which is closed by the finger. Hence all the muscles and ligaments about the joint, even the capsular ligament, may be cut through, without the weight of the leg causing the head of the femur to recede in the slightest degree from the acetabulum; whilst on the contrary, when all the ligaments and muscles are left entire, the head of the bone will sink from three to four lines out of the acetabulum, if the atmosphere pressure be permitted to act on the upper surface of the head of the femur, by boring a hole from the inside of the pelvis into the joint. Experiments *in vacuo** have further proved this fact, and have put to flight every doubt which could be entertained.

* Müller's Handbuch der Physiologie, vol. ii. p. 124.

Weber himself has remarked, that his discovery might be made use of for the explanation of one particular symptom of hip joint disease, viz. the elongation of the affected limb. He meant that form of idiopathic hip joint disease, in which, in persons otherwise healthy, without any external cause, the thigh bone sinks out of its socket, by which, at first, a remarkable elongation of the diseased limb occurs, and evident limping, (as in Fricke's Coxalgia, *sensu strictiori*,) this elongation is produced in this manner, either through the action of the secreting vessels depositing a watery fluid or a firm substance in the cavity of the joint, which causes that the femur should be depressed from the joint in the proportion of its increase, and that it should sink outwards by its own weight, without the ligaments being capable of giving the slightest opposition.

That this pathological deduction, volunteered by Weber, is not very striking, Lauer* has evinced, and has well remarked that in such process the thigh bone by no means sinks out of the acetabulum by its own weight, but is pushed out of it by a process altogether peculiar; for a watery fluid or a firm substance exuded into the joint, would act quite differently from air permitted to enter through a hole in the acetabulum. The latter is in connexion with the whole atmosphere, and presses the head of the femur with the same force outwards, as it did before the hole was bored, in the contrary direction: but in the exudation this is not the case: here the operation of the atmospheric pressure was only modified and not removed. Other objections may be made to Weber's conclusions. According to his own work, the acetabulum with its ligamento-cartilaginous border, describes only in one direction, viz. from before backwards, a perfect half circle of 180 degrees, but in every other direction a smaller segment. The edge of the acetabulum is placed at farthest only on the greatest circumference of the spherical head of the femur, and as it does not project out

* See second vol. of *Zeitschrift für die gesammte Medicin*.

over this, it cannot at all assist in retaining the head of the bone in the socket. Every force therefore, which expels the head of the femur from the acetabulum, must, since it removes the contact of the edge of the acetabulum, from the greatest circumference of the head of the femur, bring it always to a smaller segment of the egress of the acetabulum. Also in proportion as the head of the femur is forced out, there exists between it and the border of the acetabulum, a greater or less empty space of a circular form, into which the greater part of any watery fluid in the joint must flow of necessity, whereupon also the pressure of the atmosphere, without any activity of the muscles, must instantaneously drive back the head of the femur into the bottom of the acetabulum, consequently the capsular membrane must be perfectly full of watery exudation, before in this manner a permanent elongation of the limb can occur. It follows from this explanation, that Weber must have entirely disregarded the share which must be allowed to the activity of the muscles, as those who are affected with this slight degree of suffering in the hip, and who are accustomed to go about for a long time, find in consequence, the femuro-pelvic muscles constantly in a state of powerful contraction. We can imagine thus, that by the atmospheric pressure acting at the same time, a very small proportion of muscular contraction would suffice to draw back the head of the femur into the acetabulum, and we can also think, on the same grounds, that it could only be by nearly perfect filling of the capsule of the joint with exuded moisture, that any lasting elongation of the limb could occur.

If we cannot unconditionally concur in Weber's pathological conclusions, this however cannot do the slightest prejudice to the weighty influence of his discovery in general upon pathology. For, first, from his experiments it is undeniably proved, that when there is no affection of the joint, and when there is only disease of the muscles or ligaments, be it of what kind it may, by no means can any separation of the head of the femur from the acetabulum, and a consequent elongation of the leg, be

effected. Even perfect paralysis of the muscles cannot produce it, a fact which any one can convince himself of, if he should still hold such proof necessary.

The evidence which Fricke has given on the same disease, to which he has applied the name of *Coxalgia Sensus Proprio*, is no longer of any avail in the present state of knowledge, but must be replaced by other proper to the times. The experiments of Weber with the above mentioned limitations offer themselves as simple and uncontradicted, and one might in the greater number of cases of coxalgia, in the sense in which Fricke applies that term, form a tolerably correct diagnosis, when he felt disposed to account for the lengthening of the limb, either by a serous or purulent effusion, or even by an extravasation of blood into the joint. Collections of this kind are also formed by the abundant communication between the bursa iliaca and the joint, and by the common occurrence of dropsy in the bursa; by the transference of the same to the hip joint, the occurrence of dropsy, or of very marked symptoms of disease of the joint, is more easily discovered. Two arguments appeared to be opposed to the theory of Weber: viz. 1st, the pretended results of experiments instituted by Fricke on subjects: and 2nd, the constantly remarked wasting of the muscles of the thigh observed by him in cases of coxalgia sensu strictiori, which will not permit us to exclude altogether the sympathy of the muscles. What may be the value of the experiments of Fricke practised on subjects, is not clearly intelligible, which consisted of freeing the head of the femur from its connexion with the joint, by a simple incision, and having wrapped it in linen, so replacing it; or those of Weber in which the head of the bone was not surrounded, but the acetabulum filled with charpie, for in measuring the limbs in both of those cases, no difference could be found. For as it is proved that by the simple access of air to the joint, the head of the femur is separated three to four lines from the bottom of the acetabulum, and the whole leg is even so much elongated, so we cannot

conceive but that if in these experiments the same space which was filled with air were filled by a firm body, that there would not be an equally remarkable elongation discoverable by measurement. The difference appears to arise from this, that the experiments of Weber were made on bodies, the inferior parts of which were hanging down; whilst those of Fricke were made on bodies placed in a horizontal position. In the latter cases the limb could not be acted on by its own weight, but on the contrary, being brought into the same horizontal position with the other, whilst the artificially enlarged head of the femur which it would be now impossible to return into the acetabulum, would occupy an unaltered situation, probably externa and superior against the edge of the acetabulum; a circumstance which would make these different results of measurement easily intelligible. The wasting of the muscles, however, which Fricke gives as the constant and characteristic symptom of his coxalgia, and sometimes a peculiar softness of the muscles to the touch, contains nothing dissonant to the etiology of Weber's hip joint disease; however, in place of a primary symptom, as declared by Fricke, it should be taken as a secondary one, as the patient is compelled to support the body on the sound limb habitually, and only to draw the affected one, which does not offer him proper security, after him; on which account its muscles from inaction, necessarily degenerate into a state of softness, which is much increased when a quantity of fluid is collected in the joint, and perhaps aggravated by the unaccustomed distention which the muscules suffer. *En passant*, we may remark, that this peculiar and equally doughy softness of the muscles, may find its explanation in a sentence of Weber's, which may here be introduced. In his mechanism of the joints, he says: "The condition of the muscles during life alternates between the extreme of stiffness and the extreme of softness, much more than after death. Also after death the difference between the muscles during the rigidity which succeeds it, and after that is passed, is very great: during life, on

the one hand, the muscles can, during a violent effort, attain, for a short period, a stiffness and hardness far greater than that occurring after death, and which makes them like to the bones : on the other hand, their softness, when perfectly relaxed during life, exceeds in a similar ratio their softness after the stiffness of death has passed.

It may further be inquired ; if an elongation of the leg never can arise through simple atony or paralysis of the muscles, without there being at the same time an affection of the joint, how on the contrary can it have any connexion with the shortening of the limb ? Can this be effected by simple sympathy of the muscles, or by a condition of permanent contraction, or by spasm of the muscles ?

So long as the operation of the atmospheric pressure upon the hip joint was unknown, and the generally received opinion was, that the femur was held suspended in the acetabulum by the muscles and ligaments, and that the head of the femur possessed a certain space for motion, which was decreased by every action of the muscles, and increased by every relaxation ; there was nothing unnatural in the theory that a simple condition of irritation of the muscles might produce a permanent shortening of the leg, and we need not wonder that the muscles were supposed to play the first parts in the shortening occurring in hip joint disease, as well as in contusion. Weber's researches have also instructed us better on this point, for if the head of the femur be in a condition to close the acetabulum in an air tight manner, then there can remain no unfilled space between the articulating surfaces of both, as each must move on every part of the other, for we cannot take into account the perfectly unmeasurable space which the synovia occupies. That this was really the case, Weber convinced himself by making several sections through the whole joint in various directions, and also by taking casts of the head of the femur, and of the acetabulum in plaster of Paris. The solid half sphere, taken as a cast from the head of the femur, fitted so exactly in

the hollow impression from the acetabulum, when the unevenness arising from the cavity for the ligamentum teres had been taken away, that a small slip of paper prevented in a remarkable manner the entrance of the artificial head into it, which would not be the case if both surfaces of the joint were not segments of equally large spheres.

Hence we can no longer speak of space existing between the head of the bone and the acetabulum, which, on Palletta's authority, was regarded as proved, and shortening by the mere action of the muscles could only be conceivable by a consideration of the practicability of the cartilages covering their surfaces being compressed, as Fricke, Wernher,* and others have thought to be the case. Yet if any one would consider that the thickness of those in most places is only one line, in a few a line and a half, and at the most three lines, for both cartilages considered together, and if he should try to compress pieces of cartilage which were cut off between two masses of wood or glass, and found the remarkable resistance which they give to great pressure, then would he be very little inclined to lay great stress to attributing the shortening to this cause, and particularly if he had experienced how uncertain measurements are in living persons, when it concerns so small a space as one line, or half a line. Wherefore, the muscles have just as much power by their contraction alone, to produce a shortening of the limb, as on the contrary, by mere relaxation to produce an elongation. But even in organic injuries of the joint, in real hip joint disease, it will depend entirely on the situation and the circumference of the lesion, whether shortening may follow it or not. We have seen that the head of the femur and the acetabulum are closely attached to one another, like an hemisphere closely and accurately embraced by a capsule. Such an hemisphere can only sink deeper into its capsule by a diminution of its whole volume, or the capsule must be enlarged in

* See Schmidt's Jahrbücher, vol. xiii: Part 1, p. 108.

every part. Any partial alteration in the relative dimensions of both, would only remove in some situations the motions of one surface on the other, but would not cause the entire convex surface to pass deeper into the concave. Thence it would be possible to remove a large segment of a sphere from the head of the femur, as in Fricke's fifth experiment, or a similar portion from the back part of the acetabulum, without causing by this means any shortening, and consequently the destructive caries in hip joint disease must have already included the entire superficies of the head of the femur, or of the acetabulum, before evident shortening can be found as the effects of it. This agrees perfectly with the experience of Rust, and of many others, who only found shortening in rare cases, and such as might be considered more properly as exceptions to the first stage of hip joint disease; yet they regard it as a constant and necessary symptom of the earlier stages of the disease, and that it never is absent where the diseased limb, on a superficial examination, appears longer than the sound one: thus any one might imagine at a first glance these two declarations are so evidently opposed, that if one of them stand, the other must necessarily fall. Both, however, can be associated together, without difficulty, as we shall presently shew; and we have only to discriminate accurately the observations from which these two opinions have been deduced, and avoid transferring the characters of one set to the other. It is well known that English surgeons (Falconer, Crowther, and Brodie) first drew attention to the remarkable protrusion or sinking of the pelvis of the affected side in hip joint disease, and distinguished from real, an apparent elongation of the limb, arising from this oblique position of the pelvis. Brodie endeavoured to determine the real, by measuring the distance between the anterior superior spine of the ilium and the patella, which measurement Fricke modified in a most useful manner by selecting in place of the patella, the external inferior condyle of the fibula, which afforded a less moveable and more equable point

for placing the measuring instrument upon. By this improved method, and by the most careful examination of each individual case, Fricke obtained results always the same, viz.: that in apparent elongation of the limb, there was always real shortening, which amounted nearly to the same extent as the apparent elongation.

This fact, to that period overlooked, has been placed by Fricke's numerous measurements beyond all doubt, and now all that is requisite, is a correct and physiological explanation of this phenomenon.

Fricke looked upon an increased contraction of the muscles of the hip, to which they are excited by the continual pain in the joint, and by means of which the head of the femur is pressed more powerfully into the acetabulum, as the cause of the shortening which is found. On one side, however, there is opposed to this what we have said above with regard to the connexion of the head of the femur to the acetabulum, and also the slight compressibility of their cartilaginous envelopes, and on the other side, that in all cases of hip joint disease, a permanent state of contraction of the muscles has not been observed; for how would such permanent contraction of the muscles agree with the great depression of the pelvis on the affected side, which we concur with Brodie in considering, to be, without doubt, a passive state, from the usual gait and limping of persons afflicted with *morbus coxæ*, both of which are attempts to avoid every muscular effort of the affected leg, and to throw the whole weight of the upper part of the body, and every motion demanding exertion on the sound limb. Also the diminished rotundity of the muscular parts about the joint, and the well known state of relaxation of the glutei muscles, are not favourable to this opinion; finally, it is unlikely, that by perfectly different degrees of intensity of inflammation and of pain, at different periods, and in different subjects, that the muscles should ever find themselves in an over-excited condition. Besides the feeling of contraction in the muscles, to the hand of the examiner, can be easily explained, for at the very moment

of the examination, the pain which is caused or increased may give rise to an instantaneous contraction of the muscles, through recurrent branches of the inflamed nerves when touched ; this, however, proves nothing with regard to a permanent and pre-existing state of contraction.

All these grounds are more particularly supported by this, that every phenomenon of real shortening with apparent elongation, explains itself most perfectly in another way, by which we can abstract the greatest part from the agency of the muscles. Fricke has already drawn attention this, that the appearance can be produced just as well in persons in health, and that any one can remark it easily in his own person by holding both legs together, whilst he endeavours at the same time to make one leg longer than the other, by which act the apparently elongated limb will actually measure three or four lines shorter than the other. " This phenomenon," proceeds Fricke, " has the same cause as in morbus coxæ, inasmuch as by the effort to make one leg longer than the other, all the muscles in the thigh of the former are placed in a state of activity, and by the depression of the pelvis the head of the femur is driven with still greater force into the acetabulum." But it is not alone in healthy living men, but also in subjects, where no consideration of muscular action can enter, that this experiment can be illustrated, with the same results, if one of the lower extremities be fixed whilst we lay hold of the knee and heel, and raise it upwards whilst kept in a perfectly extended state, slowly beside the fixed extremity, during which, however, even the slightest bending of the knee, or any turning of it inwards must be carefully avoided. Then it may be seen that in the same proportion as the crest of the ilium on the shortened side is raised higher, the opposite one sinks down towards the fixed limb, and gives the same result on measurement of the elongated side from the anterior superior spine of the ilium, to the external condyle of the fibula, as it does in healthy living persons, viz. a shortening of from three to four lines in comparison

with the length of the leg in the ordinary position of the pelvis. That there is no forcing of the head of the femur against the bottom of the acetabulum in this experiment, but only a simple lateral inclining of the pelvis around the head of the femur of the fixed leg, stands in need of no proof. If any one, however, was determined to retain the idea of violent pressure into the hollow of the acetabulum causing shortening, then such a person would find it sooner in this experiment on the apparently shortened side, as here the obliquity of the pelvis is caused by the powerful shoving upwards of the whole extremity against the pelvis. Here, however, not only is there no shortening of the space between the spine of the ilium and the external condyle of the fibula, but on the contrary an elongation, and this condition, which was over-looked by Fricke, gives us the best explanation of the whole phenomenon. It is thus that this happens, by every inclination of the pelvis, the whole ilium of the depressed side comes nearer to the trochanter major, whilst on the opposite, the ilium recedes in the same degree from the trochanter major of the other leg, by which circumstance an elongation occurs here, and a shortening there, of the space between the trochanter and the spine, and consequently the same must occur in the whole limb. This process may be rendered more evident by considering the head of the femur as the centre, and the leg itself as the radius of a circle, the periphery of which marks the distance of elongation which would be described by a lateral rotation of the heel in the horizontal position of the body. The anterior spine or any other point of the half pelvis would stand inside this circle near the centre, and thence, according as the leg was moved to one, or the other side of the circle, at one time it would approximate to the under side of the leg, at another distance itself from it, by which means the space in the first case would be shortened between both points, in the latter increased. Now what can be effected by lateral motion of the leg in its socket, whilst the pelvis is fixed, can also be accomplished whilst the legs are

fixed by lateral twisting of the pelvis on the thigh bones, although on account of the circumscribed motion not to the same extent. Hence it happens that the real shortening which is always found with apparent elongation of the leg, and at the same time on the opposite side, the real elongation with apparent shortening, alters only so far by an action of the muscles, as can be produced by inclining the pelvis obliquely to one side or the other by the action of the muscles during life; but the principal cause of this appearance is to be found in each lateral motion of the pelvis, or in other words, in the altered position of the portions of the bone of the pelvis to those of the inferior extremities.

That this fact, which has hitherto been disregarded in an extraordinary manner, cannot remain without influence upon the formation of doctrines of hip joint disease in general may be readily imagined. The first and proximate argument which we would deduce from this is, that in all cases where already in the first stage of morbus coxæ, a depression of the pelvis occurs on the suffering side, also a real shortening of the affected leg is to be found, and that thence the assertions of Rust and Fricke, so contradictory in appearance, are only to be distinguished into those cases in which obliquity of the pelvis has not appeared, and those in which it has, in order that they may coincide without false conclusions with one another. The distinguishing of those different cases is of so much the more consequence, as it appears from Fricke's observations and accurate measurements, that the obliquity of the pelvis in morbus coxæ is much more frequent than Rust and other German surgeons are disposed to consider it, and that it is not to be regarded as a rare exception. Perhaps Fricke saw it abundantly because his examinations of this condition were principally made in hospital practice, and also almost entirely on persons of the labouring class, who, when the inflammation did not come on very severely, which it is well known is seldom the case, pursued, as is invariably the case, their ordinary avocations, after

the access of the first symptoms had passed, and engaged in laborious occupations, by means of which the promotion of a depression of the pelvis on the diseased side must be necessarily favoured. If on the contrary the patient can from the commencement keep his bed, and observe a quiet, horizontal position, the pelvis can hardly be altered in position, to which Brodie has already drawn attention: "that the apparent elongation of the extremity, is very soon lost by the patient being kept in a perfectly passive condition."

But it is not alone in the theory of morbus coxæ, but also in that of contusion, that it is of importance to know that a simple change in the position of the pelvis with regard to the inferior extremities, or of those to the pelvis, is sufficient to produce a so called real shortening of the extremity. Contusions occur to the thigh principally on the outer or posterior side, and shortening of the extremity, whether apparent or real, which appears hitherto not to have met with due consideration, is a very frequently accompanying symptom. The opinion formerly given, and which was regarded as satisfactory, namely, the pressing in of the head of the femur into the acetabulum by increased muscular contraction, can avail as little here as in the first stage of hip joint disease. On the other hand, the discovery of a depression of the pelvis on the injured side, [compare this paper with Guerin, vol. ii. p. 224,] or an external abduction of the leg, without more, is sufficient to unveil the cause of the shortening, and we have only to determine whether the lateral approach of the pelvis and of the inferior extremity be caused by muscular contraction; that is, whether it be active, or, according to the opinion of Brodie in morbus coxæ, a passive sinking down of the affected side; because the male patient bears the whole weight of the body on the sound extremity, in order to diminish the pain, and the female patient takes advantage of it, in order to support the equilibrium of the body.

Sufferings from contusions on the outer side of the leg will often be explained by tumours and abscesses, consequently such

occurrences in the neighbourhood of the joint must not be overlooked. For want of individual experience, I must leave the application of this subject to those who have enjoyed opportunities more abundantly and accurately of proving those points by clinical observation, and which I have only spoken of in a physiological respect.

To induce further practical research, we will only remark, that hitherto every one was deceived when he considered the actual length of the unaffected side, when previous obliquity of the pelvis had existed, as the normal length of both limbs; for as we have shewn, also on this side by the altered position of the pelvis, the ordinary relations of the dimensions is modified, as is exemplified in the apparent shortening of the sound limb, which most frequently is the case, and where constantly real lengthening is to be found. Above all, this limits in a certain degree the value of general measurements; for it never will be easy to calculate the natural length of the extremities before the pelvis became oblique, after that occurrence has taken place, particularly if already, in consequence of the process of inflammation, changes of form may have occurred to the acetabulum or to the head of the bone, which may have their share in the production of real shortening. However, if the measurements be made with circumspection and prescience, it will always be a diagnostic assistance of the greatest consequence, and it might, if pursued after the method indicated by Fricke, possibly, give unerring results.

In conclusion, I must speak my conviction, that after the disclosures, which on the part of physiology we have given on this subject, a perfectly new course of pathological research is required, in order to raise our theories of hip joint disease to the height of a perfect knowledge, of which is now capable, and which is now more than ever necessary. Particularly is there urgent necessity, that at last by accurate diagnostic signs the diseases of the hip joint should be distinguished from those of the parts surrounding it, as well as those diseases of the

joint which are not inflammatory from genuine morbus coxæ — a wide field for surgical inquiry, and in which a rich reward is to be earned.

May these lines, which proceed from the purest motives of affording information, serve at the same time as a challenge to the honoured editor of this periodical anew to turn his particular attention to a portion of pathology which, under far more difficult circumstances, evidently demanded, and always was treated by him with attention not to be mistaken. The valuable opportunity which presents itself of observing diseases of the hip in our General Hospital, (Hamburg,) allows us to hope still more useful results, from a recurrence of observations on diseases of the hip, with regard to the modifications of the physiological foundations, now become necessary; as well as from similar researches in many other clinical institutions, and we may rely on a careful attention being paid to the cases which may occur, for the advancement of science, so much the more certainly, as the surgical section has never shrunk from its engagement, but has always in the most praiseworthy manner promoted the cause of knowledge, and the science of medicine, after a due regard had been paid to the patients intrusted to its charge.