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A Critical Inquiry into the Causes of the Internal Rotation of the Fœtal Head.

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Internal Rotation discovered: Early Views of its Causation: the Supposed Influence of the Ischial Spines.

Up to the middle of the eighteenth century, it was thought that the fœtal head entered the pelvis with its long (*i.e.*, antero-posterior) diameter in the conjugate and its face towards the sacrum, and that it crept into the world on its hands and feet. Sir Fielding Ould, of Dublin,[1] was the first to reject this conception, and in 1742 he stated that in natural presentations, whilst the chest of the child lies on the maternal sacrum, the face is always turned to one or other side with the chin directly on one or other of its shoulders.

Smellie[2] accepted this view of Ould's that the fœtal head entered the pelvis in the transverse diameter, and pointed out that the head changed its position at the outlet so as to be born with its long axis in the conjugate; a change which he considered due to the action of the bony pelvis, and which was only brought about when the head had reached the pelvic floor and had begun to experience the resistance offered by the ischial spines.

It was left for Saxtorph[3] and Solayres[4] to show that these views were erroneous, and that the head entered the pelvic brim with its long axis in one or other of the oblique diameters; an opinion that was held by Berger, the teacher of Saxtorph, and which he gave in his lectures probably prior to 1759 (Leishman). Saxtorph, who, however, worked out the mechanism of parturition for himself, agreed with Smellie that internal rotation of the head occurred at the outlet of the pelvis and was due to the pressure of the ischial spines. Solayres, the teacher of Baudelocque, who directed attention to the work of his master, discovered from his own observations that the head in normal cases lies obliquely at the brim.

Schmitt[5] (1804) accepted these views, but thought internal rota-

tion of the fœtal head was solely due to uterine activity; a view which, strange as it appears, has within recent years again been brought forward. He says: "Writers have erred in ascribing the cause to the resistance which the head meets with in the side parts of the pelvis and to the convenient space afforded by the hollow of the sacrum, for the real cause is grounded more deeply in the directing power which, in conformity with mechanical laws, is afforded by the uterus." (Quoted by Leishman.*) In support of which he advances that rotation occurs even in footling cases.

Naegele [6] (1819) pointed out that the head reached the pelvic floor still obliquely placed, and engaged the opening therein in such a fashion that the caput succedaneum was formed in left occipito-anterior positions, not medianly, but laterally over the upper and posterior angle of the right parietal bone; and, further, that it was actually born, not with its long axis (sagittal suture) coinciding with the conjugate, but also somewhat obliquely.

He stated the occurrence of occipito-posterior presentations is much more frequent than was at that time supposed: a fact which he considered was due to insufficient or to too late examination of the cases, since most of them during the process of birth undergo a rotation so that the third vertex becomes converted into the second with a natural birth. This rotation, Naegele considered, was due to the resistance offered by the "floor of the pelvic cavity or the steep surface, which is formed by the lower part of the sacrum, the coccyx, and the sacro-coccygeal ligaments." These force the occiput to turn from behind forwards so that the long diameter slowly rotates into the left oblique diameter. He therefore practically accepted, as regards this point, the views which had been expressed before him.

Leishman [7] (1864) confirmed the statement made by Naegele that the head is born obliquely in the following way:—Whilst an assistant held one end of a cord against the tip of the coccyx of a woman in labour, the other end was carried forward along the middle line of the vulva to the centre of the symphysis pubis. As the advancing pole of the head first appeared at the vulva and came to press on the cord steadily held in this way, Leishman drew a line by means of a camel's hair pencil moistened with ink along the cord upon the head. It was found at the final exit that the centre of the posterior margin of the vulva was not in relation with the sagittal suture and central line of the face, but in continuation of a line which passed over the left malar bone.

Leishman believed that the most important factors concerned in rotation are the ischial planes and spines, because they form fixed points of resistance which determine the direction of motion. He argued: Since these bones gradually converge as they descend and encroach greatly upon the transverse diameters of the floor of the

*I have been unable to obtain a copy of Schmitt's book.

cavity, they of necessity cause the head to assume a different position with reference to the bony canal. He discussed the action of the so-called ischial planes, and said it was assumed, that whilst the anterior directs the occiput forward, the posterior plane of the opposite side directs the forehead backward towards the sacrum. Whilst he believed that the part played by the posterior ischial plane had been exaggerated, he was of opinion that the anterior ischial plane with the ischio-pubic ramus and the soft parts which cover the obturator foramen "form a large surface, which is bevelled off in front and is in every respect admirably adapted to the end in view."

Apparently many writers on obstetrics have thought that the projection inwards of the ischial spines is a dispensation of Nature, specially evolved for the mechanism of internal rotation: as though this movement, indeed, were a *sine quâ non* of childbirth. But internal rotation of the fœtal head as a mechanism occurring during this act is not an essential condition, for if the pelvis is big enough and the fœtal head small enough the head can be born without internal rotation. This movement is only an accident; it only results because the fit between the head and the pelvis is a close one, and because the musculature of the pelvic floor resists delivery and thereby makes the fit a closer one than it otherwise would be. The inward projection of the ischial spines, from which the posterior parts of the levator ani muscles and the ischio-coccygei (coccygei) arise, is also an accident: an evolutionary incident merely. It has been brought about by the change in the direction of the pull of the musculature of the pelvic floor, which the assumption of the erect posture determined: just as the position and shape of the lesser trochanter of the femur has been caused by the traction of the psoas muscle. That this is so is shown by the examination of the pelves of the lower animals, in which no such inflection of the ischial spines is found. With these and other evolutionary changes birth continued to take place, and could only do so by an adaptation of the fœtal head, enlarged by the growth of the brain, to the structure of the pelvis—an adaptation which consists of various rotatory movements of which one is the subject of this inquiry. The pelvis itself, however, in the female has undergone modifications in adaptation to the increased size of the fœtal head, in that it has become wider and shallower. But the projection inwards of the ischial spines occurs in both sexes; if it be more marked in the female than in the male it is only because the female pelvis is wider, the pelvic floor musculature for this reason stronger, and the pull on the spines therefore greater.

The conception of the part played by the ischial spines continued to hold sway for many years, indeed until Veit [8] (1887) and Varnier [9] (1888) showed that the bony pelvis of itself was insufficient to cause

internal rotation. It is clear, if the old view had been correct, that, when the head enters the pelvis in the oblique diameter with the forehead anterior, the forehead ought to be directed towards the pubic arch and the head to be born with the occiput behind with the same frequency with which in first vertex cases the occiput is directed forward. But this does not happen. In the great majority of primary occipito-posterior cases a rotation of the head occurs during its passage through the pelvis, so that the forehead looks posteriorly when born.

The View that Internal Rotation is caused by the Pelvic Floor.

Since it was shown that the bony pelvis was not responsible by itself for internal rotation, obstetricians began again to ask themselves what factor determined it. Some believe that it is the pelvic floor itself which causes it, and this seems to be the prevailing opinion. Veit, from his study of the subject, came to this conclusion. Whitridge Williams [10] accepts this view, and argues that since the opening in the pelvic floor is oval in shape and retains this outline (so he says), even when markedly distended, "the head must adapt itself to this in order to be born." Against this, however, it may be said that in ordinary vertex presentations the part which bulges through the opening, before extension is continued by the intact perineal body, is almost circular in circumference, the difference between the bi-parietal and sub-occipito-bregmatic diameters amounting only to 0·5 cm. Moreover, when the pubic arch is sufficiently wide and the distance between the ischial tuberosities normal (11 cm.), it is difficult to accept the statement that the transverse diameter of the opening always remains considerably less than the antero-posterior diameter, because, if the opening is to retain its shape, the posterior boundary will have to recede twice as far as each lateral boundary is pressed aside, for the anterior boundary, the pubic arch, is fixed (immobile); and surely as much, or even a greater, resistance will be experienced by the fœtal head in determining a recession of the posterior boundary of the pelvic floor aperture as in the separation of its lateral margins. The difficulty of delivery in persistent occipito-posterior cases, which is caused by the necessity for a greater recession of the posterior part of the pelvic floor, seems to confirm this. Further, it can scarcely be maintained that the character of the opening is sufficient to cause such a rotation as occurs in the majority of occipito-posterior presentations; for were this factor the determinant, it ought to prevent the occiput, primarily posterior, from rotating to the front.

In support of this view the following arguments have been advanced:—

(1) That Dubois [11] showed that internal rotation could take place in the dead. In a woman who died shortly after her confinement, he

opened the uterus and placed the recently delivered fœtus in the right occipito-posterior position and thrust it downwards through the maternal soft parts. He found on the first three trials that the occiput in each case rotated to the front, but subsequently, when the elasticity of the soft parts had been lost, this rotation forwards did not occur.

(2) That Edgar [12] screwed a swivel into the head of a fœtal cadaver half an inch behind the small fontanelle, attaching a yard of cord to the ring of the swivel, and repeatedly dragged the head through the pelvis of a woman who died shortly after her confinement, and found that the occiput invariably rotated to the front, even when the head entered the pelvis in the posterior positions, as long as the pelvic floor "retained its integrity." When the elasticity of the floor became impaired by overstretching, the head traversed the pelvis in very nearly the same position as it had entered.

(3) That in a case of childbirth occurring in a paraplegic, rotation of the occiput forward occurred (Amand Routh [13]).

These experiments and observations show conclusively that if internal rotation is dependent upon the pelvic floor musculature that it occurs as well when the musculature is dead as when living, as well when paralysed as when in the full vigour of its functional activity. It is, therefore, obvious that the musculature merely plays a part in causing internal rotation of the head by obstructing delivery. This was clearly shown by the continued repetition of Dubois' and Edgar's experiments, for when the soft parts had become impaired by repeated stretching, rotation failed to occur. That this obstruction, caused by the resistance of the pelvic floor to its displacement downwards by the fœtal head, is unable by itself to determine internal rotation is demonstrated by the following facts:

(1) That rotation is rarely complete (Naegele, Leishman).

(2) That it does not usually occur when the fœtal head is small and the maternal pelvis large (Herman [22]).

(3) That in bregmato-cotyloid presentations occurring in women in whom the pelvis is small and round (small round pelvis) the posterior position of the occiput persists (see Edgar*). In these cases, in spite of the fact that, because the flexion is good, the occiput, although posterior, of necessity meets the pelvic floor first, rotation does not usually occur. Here there is no question of the forehead being at a lower level and meeting the pelvic floor first. All the pelvic floor can do, when it is being depressed by the fœtal head, is to cause a projection forwards of the advancing fœtal pole in the sagittal plane towards the pubic arch; that is, in ordinary vertex cases, it causes extension, but this movement is not rotation.

* Etiology of persistent occipito-posterior position. (*Obstetrics.*)

The View that Internal Rotation (of the Fœtal Head) is caused by a Primary Rotation of the Fœtal Trunk.

If neither the bony walls of the pelvis nor the resistance of its muscular floor can alone cause this rotation, what does determine it?

Whether Schmitt[5] (1704) foresaw this difficulty or not, I do not know; at any rate he put forward the idea that the expelling force is the sole determining factor in causing internal rotation (Leishman).

A similar view was brought forward by Olshausen[14] in the editions of Schroeder's Lehrbuch, which he and Veit edited, and was elaborated in a special contribution[15] which he subsequently published (1901). In the 11th edition of Schroeder's Text-book (1891), Olshausen says (p. 194) there are two factors concerned in causing internal rotation: (1) the influence of the fœtal trunk on the fœtal head; and (2) the form and elasticity of the muscular pelvic floor. Thus:—

"The primary factor is the rotation of the fœtal trunk, the back turning from the side to the front during the expulsion period. It is not difficult to convince oneself of the regular occurrence of this rotation, which is shown by palpation and auscultation. The fœtal heart sounds during this stage of birth are always best heard towards the middle line. The rotation of the trunk is the consequence of the increasing tendency of the uterus to become flattened (antero-posteriorly) as the liquor amnii escapes. As this diminishes the uterus tends to assume its original flattened form, for it is only subsequent to the growth of the ovum that the transverse and antero-posterior diameters have become almost equal.

"The back, however, seldom completely rotates to the front. Generally, when the sagittal suture has reached the antero-posterior diameter, the back remains about 30° (Schatz) behind the rotation of the vertex.

"The rotation of the trunk has only initiated that of the vertex, which is continued and completed by the other factor, the activity of the pelvic floor. This is a gutter-like structure, formed of soft parts, which passes from behind forwards and ends anteriorly at the vulva. The already obliquely placed vertex enters with its long axis (fronto-occipital) obliquely to the longitudinal diameter of this gutter, the two lateral muscular walls of which, in virtue of their elastic resistance against the ellipsoidical head cause the sagittal suture to assume, at least approximately, the antero-posterior position."

This view of the part played by the pelvic floor is in close agreement with that of Whitridge Williams (*v. ante*).

Bumm,[16] who accepts Olshausen's explanation, justly argues: If the pelvic floor musculature is the answerable factor and causes the occiput, lying anteriorly in the oblique diameter, to rotate for-

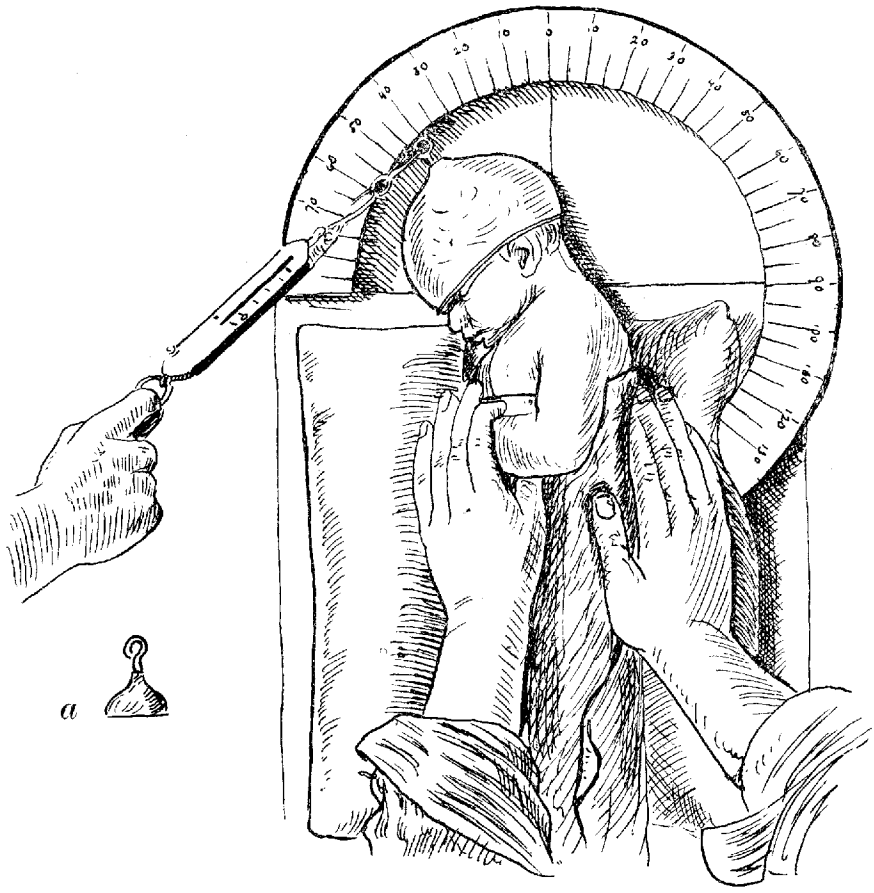

Fig. 1. From Sellheim's article (p. 14) : showing method of investigating flexibility of fœtal spine in various directions in the living child. The body is placed on a pillow and kept fixed by means of a blanket held in position by the hands of an assistant. *a* is a screw ring, mounted on wood; this is placed on summit of head and maintained in position by an elastic cap, through an aperture in which the ring protrudes. The hook of a dynamometer is passed through the ring, and the necessary force required to flex the head in various directions is determined.

wards under the pubic arch, the same factor, when the forehead occupies this position, should cause a similar rotation of the forehead under the pubic arch, and this should occur as frequently in the one case as in the other. Since this is not so, some other factor must be looked for. This he finds in the activity of the uterus. In support of this contention he says that during pregnancy the position of the fœtal head is influenced by the position of the fœtal trunk; that during labour the flattening of the uterus causes the fœtal back to become anterior; that this movement is communicated to the fœtal head; that, therefore, the fœtal head possesses the tendency to rotate forwards from the outset of labour. He believes this influence of the fœtal trunk over the position assumed by the fœtal head is sufficient to determine the anterior rotation of the occiput even when this enters the pelvis posteriorly in the oblique diameter, in spite of the counteracting influence which the pelvic floor presumably exerts. The tendency of the occiput to rotate into the hollow of the sacrum is prevented by the resistance of torsion it encounters by the anterior rotation of the trunk. "It is the trunk which institutes the anterior rotation and imparts to the occiput the impulses which cause it to rotate in the same direction." The rotation of the fœtal trunk is determined by the projection forwards of the maternal lumbar vertebral column; this prevents the fœtal back from turning completely behind, and, combined with the effect of the uterine contractions, causes it first to become lateral, and finally anterior. In this rotation the fœtal trunk carries the occiput with it.

The View that Internal Rotation is caused by the Adjustment of the Fœtus (as a whole) to the Parturient Canal.

Sellheim [17] believes the essential cause of the internal rotation of the fœtal head lies, at least in part, within the fœtus itself; and that the movement is determined by the unequal flexibility of the fœtal axis in various directions. Since the lower part of the parturient canal is curved, the cylindrically-formed fœtal body, in response to physical laws, bends itself in the way corresponding to the curvature of the birth canal. Although this rotation depends upon the existence of a force from above, it is independent of the particular kind of force (general rise of intra-uterine pressure; pressure along fœtal axis; action of gravity). He therefore does not accept Olshausen's hypothesis concerning the direct effect of uterine activity (*i.e.*, flattening) upon rotation.

Sellheim's View Criticized.

That the flexibility of the fœtal axis is not the same in all directions Sellheim shows experimentally (see Fig 1); in the region of the neck, for instance, the fœtal head can be bent backwards more easily than in any other direction. This, however, only obtains in living children, for "in dead children after the rigor mortis had

disappeared, the difference in the flexibility in different directions was considerably less than was found during life." This difference, Sellheim believes, is due to the muscle tonus of the large group of extensor muscles of the back and head (erector spinæ et capitis). The next point that he makes is that the attitude of the fœtus within the uterus, as regards the relative position of the head to the trunk, is not one of extreme flexion, which is only assumed at the onset of labour by the head being pressed downwards into the conical lower uterine segment; but the resting position is one in which the fœtal head is neither flexed nor extended. With this most will agree. It is obvious that the extensor muscles of the back, with the other body muscles, will occasionally actively contract, just as the limb muscles do (fœtal movements); for it is upon such activity that the muscular physique of the fœtus, even whilst still intra-uterine, depends.

From the opinion that the position of the fœtal head in the attitude of rest is one between flexion and extension, Sellheim argues that when the head is coerced to assume an increased flexion by entering the pelvis, the tension of the extensor muscles is increased. At the same time, in order to diminish the frictional resistance between its surface and that of the parturient canal to the lowest point, the fœtus assumes in all its parts a form approaching a cylinder as much as possible.

Thus this author supposes, that as the fœtal cylinder is thrust downwards into the pelvis the occiput rotates forwards under the pubic arch because the birth canal bends forwards in this direction and because the muscles of the fœtal back are continually exerting a traction upon the head, trying to bring it from its forced position of extreme flexion into the resting position midway between flexion and extension. That such a mechanism is possible with models Sellheim shows experimentally (see Fig. 2). But the conditions of his experiments are not analogous to those existing within the living fœtus as it is being extruded through the pelvis of the living woman. The part representing the head in the model of the birth-object is fixed to that representing the trunk by two spiral springs, and is maintained extended, although it is capable of being moved in all directions. The representation of the birth canal is a curved elastic cylinder, the sides of which readily bulge as the head of the phantom is passed through it. This is effected by an increase of pressure (air pump) from above, comparable to a general rise of intra-uterine pressure.

It is plain that if the fit is tight and the resistance to the passage of the fœtal model so great that considerable difficulty is experienced in passing it through such a passage, that a rotation of the birth-object (about its long axis) within the birth canal at the 'knee,' provided the head is capable of moving upon the trunk in all

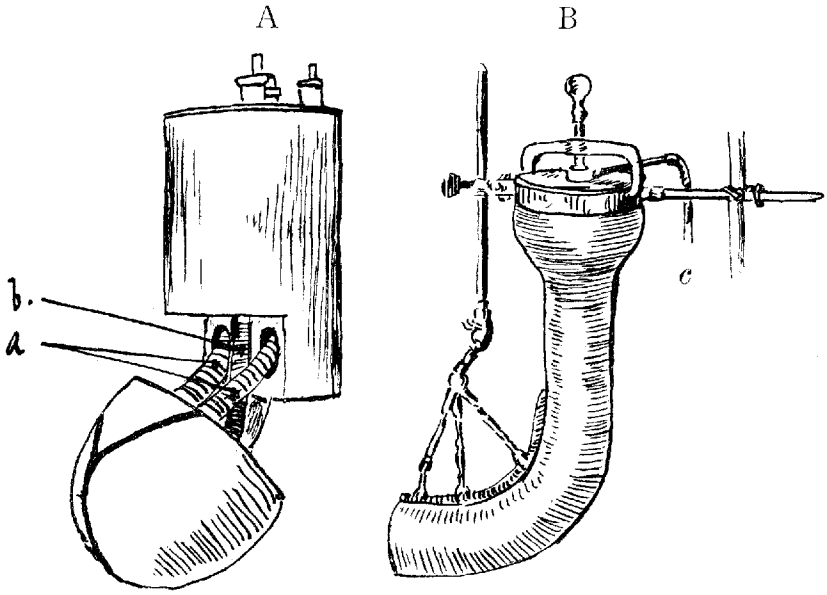

Fig. 2. From Sellheim's article (fig. 36). A represents model of the 'birth object.' *a* spiral springs, which place the maximal flexibility (Biegungs facillimum) neckwards, and evoke the tendency to extend when flexion occurs. Note that the essential difference between the phantom and the living child is that the stretched spiral springs of the one cannot tire and relax, whereas the extensor muscles of the neck of the other not only can, but probably invariably do so. *b* is a vertical spiral spring.

B represents a model of the birth canal (drawn to a much smaller scale than A). It is formed of elastic tissues and offers little resistance to the passage of the birth object A, which is effected by means of compressed air passed in by the tube *c*.

directions,* although with different facilites, will be correspondingly difficult. It can, indeed, only occur if the fœtal force, which is tending to extend the head by exerting a pressure upon the wall of the birth canal in the region of the occiput, is considerably greater than the summation of the pressure forces existing between the other points of contact around the circumference of the head and the wall of the passage embracing it. The greater the obstruction, the greater must the driving force be; the greater the driving force, the greater are the circumferential pressure forces; the greater these become, the less significant the fœtal extending force. Thus in the presence of marked obstruction—and the obstruction to the head in normal parturition is marked—internal rotation will not occur as a result of any tendency on the part of the fœtal head to extend, unless this be very great indeed. In such a case the head will merely deviate in the direction in which the cylinder containing it deviates, *e.g.*, in positions in which the fœtal head is transverse, the side of the face of the model will approach its shoulder. If, on the other hand, the resistance offered by the phantom birth canal is so slight that its sides easily bulge to allow the birth object to pass, as obtains in the experiment in question, this fœtal force can come into play and rotation around the fœtal long axis will occur.

In the living woman, however, the parturient canal, as an actual curved cylindrical passage, does not exist before labour. It only becomes distended and assumes its curved course when the pressure with which the fœtal head displaces the pelvic floor causes it to occupy a position in which the resistance it offers, from being axial, becomes partially circumferential, *i.e.*, laterally and posteriorly. During the earlier part of the second stage of labour the pelvic floor opposes the advancing pole of the head; its resistance is axial. But as the head engages the aperture, the pelvic floor is gradually displaced laterally and posteriorly, whilst the advancing pole of the head, pari passu with this descent, is directed forwards. It is during this displacement, *i.e.*, this descent, that internal rotation occurs. If it can be supposed that the activity of the extensor muscles of the fœtal back are capable of exerting a force greater than that exerted by the maternal pelvic floor in resisting displacement and distension, then the Sellheim hypothesis must be accepted and the fœtus be considered as playing a part in the mechanism of internal rotation. But it can scarcely be believed that this is so. The hypothesis is disproved by the fact that in cases in which it is certain the bony pelvis exerts no influence upon the position assumed by the fœtal head, in which, *e.g.*, the fœtal head is unusually small, or the maternal pelvis unusually large, this rotation of the occiput forwards does not necessarily, or indeed as a rule, occur: and these are just the cases in which, were Sellheim correct,

* If this does not obtain, the passage will be obstructed and the birth-object will jam within the birth canal.

we should suppose it ought to occur; for the circumferential pressure forces between the displaced pelvic floor and the fœtal head are presumably less when the fœtal head is small than when it is large, and the fœtal extending force therefore becomes more significant. On the other hand, when, in full-sized fœtuses, this supposed activity of the muscles of the back is put out of court, *e.g.*, by fœtal death, rotation of the occiput still occurs, as Dubois' experiment demonstrates.*

In the living fœtus, moreover, if increased flexion of the head is accompanied by increased tension of the extensor muscles of the head, it is scarcely credible that this increased tension can be maintained for long: for in primiparæ, at any rate, even before the membranes rupture, the head is found to assume this attitude of increased flexion; and whilst it is passing through the cervix uteri such pressure is brought to bear upon it for so long a time that these fœtal muscles will most certainly yield and relax and adapt themselves to this position of the head. Thus their tonus being reduced by continued traction, these muscles cannot exert any tendency to cause extension.

Olshausen,[18] criticizing Sellheim's view, affirms that careful examination will show that the fœtal trunk rotates anteriorly in many cases before the head, and may even do so to a greater extent than the head. If rotation of the head is brought about alone according to Sellheim's hypothesis, how, he asks, is rotation of the trunk explained? It is impossible, he says, for anyone to suppose that the trunk, already closely invested by the soft parts, is caused to rotate by the head. If it does not do so, it must rotate independently, and then this will influence the rotation of the head, favour the same, perhaps from the first institute it. If the trunk does not begin the rotation, the head in consequence does not rotate. If one observes the position of the trunk when the head is deeply placed transversely in the pelvis (vertex or face positions), one can easily confirm, in favourable conditions of the abdominal and uterine walls, the transverse position of the trunk. This is clearly recognized by palpation and the marked prominence of the anterior shoulder. In face and brow presentations, it is most evident that the defective rotation (*e.g.*, in chin posterior positions) of the fœtal trunk is the cause of the defective rotation of the head, as by exact external examination one can almost always, or very frequently, demonstrate.†

* This statement, of course, does not apply to macerated fœtuses.

† In face presentations, the convexity formed by the chest and abdomen, the result of fœtal extension, takes the place of the convexity of the fœtal back in vertex cases; and, according to Olshausen, is caused to rotate to the front in the same way as he supposes the convexity of the back in vertex cases is forced to do—the concavity formed by the occiput and back in face cases, adjusting itself to the projection forwards of the maternal lumbar spine.

Olshausen's View Criticized.

In support of the statement that primary rotation of the fœtal trunk is caused by the flattening of the uterus, which, he says, regularly occurs with the escape of a large quantity of the liquor amnii (p. 34), Olshausen [15] argues that just as at the beginning of pregnancy the enlargement of the uterus, for the most part, occurs in the antero-posterior diameter ('im Dickendurchmesser'), without which it could not lodge an ovum even of small volume; so a diminution first results in the same diameter, by which the uterus, not merely enlarged by growth, but also stretched mechanically by its contents, tends, with the partial evacuation of its contents, again to assume the antero-posteriorly flattened form. He states that Fehling (p. 35) has drawn attention to this, and that the same author has referred especially to Barbour's horizontal sections which show a progressive shortening of the sagittal diameter from the first to the third stage of labour.

Olshausen states that the degree of flattening of the uterus may be very considerable (p. 36). In support of this he brings forward as evidence the frozen sections published by Zweifel and Barbour, in the latter of which, whilst the transverse diameter of the body of the uterus was 215 mm., the antero-posterior ('gerade') was only 112 mm. He does this without qualification, although when writing of the position of the uterine axis in the living and in the dead (pp. 6 and 7), he prefaces his remarks (p. 4) by saying one cannot accept all that is seen in these frozen sections as correct, and as representing the conditions existing during life; for gross changes occur, in consequence of the weight of the organs, after the existing muscle tonus has ceased. In the same place (p. 6) he adds that the frozen sections there referred to* were fixed, as most of the descriptions expressly state, in the dorsal decubitus. In this position it is clear a flattening of the uterus is most likely to occur; indeed, it would be remarkable if it did not do so.

But Barbour [19] had his specimen frozen in the erect position. He was unable to obtain the whole cadaver; the pelvis and lower portion of the abdomen up to half an inch above the umbilicus anteriorly, and to the third lumbar vertebra posteriorly being removed. The section referred to by Olshausen is figured in Plate IV.[20] It has passed through the fourth lumbar vertebra and the representation is life-size. The uterus is markedly flattened from before backwards, the posterior wall being bulged forwards medianly by the vertebral column, so that the uterine cavity is reniform on transverse section. The figure, measured by a tape, gives $8\frac{3}{4}$ inches for the transverse diameter (outside measurement), and $5\frac{1}{4}$ inches for the antero-posterior. It is difficult to account for this extreme flattening in the absence of the conditions obtaining

* *i.e.*, those dealing with the uterine axis.

during the freezing. It may have been produced by direct pressure against the side wall of the vessel in which the freezing took place. At any rate, the section cannot be taken as showing what occurs during uterine activity, for we cannot suppose the maternal lumbar column can bulge the posterior uterine wall inwards when the uterus contracts. Clinically, we know, that on contraction the uterus tends to become more cylindrical or pyriform, the abdominal swelling becoming actually more prominent in spite of the simultaneous contraction of the abdominal wall musculature. Under these conditions it is difficult to understand how any flattening of the uterus can occur, or how the presence of the natural lordosis of the maternal lumbar vertebral column can influence the position of the fœtal trunk during uterine activity. And if the possibility of a torsion of the fœtal trunk by a primary rotation of the fœtal head be denied for the reason, which Olshausen offers, that the fœtal trunk is already closely invested by the soft parts, how is it possible for the uterus itself to cause the fœtal trunk to rotate in the presence of such a close investure? Even if the frictional resistance to rotation between the fœtal trunk and the uterus is greater than the frictional resistance between the unyielding walls and muscular floor of the pelvis and the fœtal head, as it may be when all the liquor amnii has escaped and the fœtal trunk is tightly grasped by the vigorously contracting uterus, still this is not the normal condition; and it is not impossible that the uterus itself, even when its musculature is contracted about the contained fœtal trunk, may be capable of being rotated to some extent, whilst the fœtal head within the pelvis, provided it be of average size, can only rotate by its continued descent so great is the resistance to its movement.

But even supposing, for the sake of argument, that this factor causes rotation of the fœtal trunk and that this determines the fœtal head to undergo "internal rotation," since this factor, if it occur, comes into play early in the second stage of labour, the rotation of the fœtal trunk ought also to occur early, and this in turn should determine an early rotation of the fœtal head. Further, this rotation should become progressively more difficult as labour proceeds and the head becomes jammed deeper and deeper down in the pelvis. Yet clinically we know that rotation only occurs late, as the position of the caput succedaneum to one or other side of the sagittal suture plainly shows. Indeed, rotation is rarely complete (Naegele, Leishman, Williams); but such as does occur is produced only when the head is thrust right down upon, and is closely embraced by, the contracting pelvic floor musculature.

Finally, that uterine activity can influence the position of the fœtal head during parturition and cause its rotation is immediately met with the objection that the limit of lateral movement of the head upon the trunk (or of the trunk upon the head) is considerable,

amounting to 90° without injury, and at first sight it appears impossible to accept the notion that torsion of the trunk could influence or cause a rotation of the head.

It is universally admitted that the head enters the pelvis with its long diameter in one or other of the oblique diameters of the brim according to the relative sizes of the head and the musculo-osseous entrance to the pelvis (*n.b.*, position of psoas muscles); and it seems only reasonable to suppose that as the head sinks downwards within the pelvic cavity that the shoulders of the fœtus, coming into relation with the brim, will similarly adjust themselves in accordance with the least resistance that their entrance admits, and that this is the real cause of the rotation of the fœtal trunk. This may occur apart from a similar rotation of the head, and if the shoulders come into relation with the brim before internal rotation of the head takes place, then the shoulders themselves may rotate before the similar movement of the head, a condition which Olshausen states frequently occurs.

If, however, it is difficult to believe that the position of the fœtal body can cause the occiput to rotate forwards under the pubic arch, even when the head enters the pelvis with the occiput placed anteriorly in the oblique diameter, much more difficult is it to accept this as the responsible factor for that greater rotation which usually occurs when the occiput is placed primarily behind. Sometimes, however, the mechanism which causes this rotation fails, and the posterior position of the occiput persists. As far as I have been able to discover, Sellheim gives no explanation of, or indeed reference to, this persistence. Olshausen, however, referring to occipito-posterior cases, says that whilst it is sufficiently known that usually a rotation of the occiput to the front sooner or later occurs, the cause of this is scarcely to be interpreted by the usual explanation (*i.e.*, influence of pelvic floor). But if, as often happens, the forehead originally occupies a lower position than the occiput, perhaps kept back at the pelvic inlet, then one must suppose, in accordance with the customary explanation, that the forehead, as the deepest lying part, is forced by the inclined plane ('durch die Gleitbahnen') to turn to the front. This, he says, only occurs exceptionally, because the fœtal back itself almost always turns to the front and forces the occiput likewise to rotate in this direction (p. 38).

West's View.

West, of Lincolnshire, [21] (1856) wrote clearly upon this question. Not only does he differentiate between the two varieties of occipito-posterior cases, but he states they are essentially different presentations. "That bregmato-cotyloid are in truth vertex presentations, but fronto-cotyloid are not." It is therefore not surprising to find the mechanism in each is distinct. He says it is a mistake to suppose

because the occiput is behind that it is wrongly placed; when flexion is good the vertex is then lowest in the axis of the brim, and consequently nearest and most ready for the outlet. It is not because the forehead is originally placed more *forward* that it finally passes under the pubic arch, but because that end of the head, being in the axis of the uterine efforts, first reaches the inclined plane of the coccyx and the floor of the pelvis, and thus slides forwards to the outlet.

Flexion of the Fœtal Head an important Factor, but not for the reason alleged.

There is no doubt that the rotation of the occiput forwards in occipito-posterior cases depends for one of its factors on the marked flexion of the head, as West pointed out; but the question is: How is the mechanism caused? West believed it resulted from the advancing pole of the head meeting the "inclined plane of the coccyx and floor of the pelvis"; and that in persistent occipito-posterior cases, owing to insufficient flexion, the anterior part of the head (forehead) comes into relation with the pelvic floor first, and is thus ushered forwards towards the pubic arch.

I do not know of any proof that may have been advanced to show that the forehead in fronto-cotyloid presentations is, as a matter of fact, on a lower level than the occiput and that it meets the pelvic floor first; but it seems to have been assumed that it is so. This assumption, which was necessary for the explanation of the persistence of the posterior position of the occiput, may rightly be objected to, for these cases are bregma presentations and not brow presentations; the condition is not one in which extension has occurred, but instead of flexion being good, flexion is not so good. The occiput and sinciput are approximately on the same level, and meet the pelvic floor simultaneously, *i.e.*, they are in a plane at right angles to the axis of the pelvic inlet along which the expelling force acts. There is certainly not the disproportion in levels between the position of the forehead and that of the occiput as exists in bregmato-cotyloid presentations; although, from the anterior situation of the pelvic floor aperture, the oblique position of the vagina and, therefore, of the examining fingers, the forehead may be felt more readily, because more anterior, than the occiput, and may, therefore, appear to be lower in the pelvis than it in reality is. From the fact that the pelvic floor of itself is unable to effect such a rotation as occurs in the majority of occipito-posterior or even of occipito-anterior, cases, in which, owing to good flexion, the occiput undoubtedly forms the advancing pole of the fœtal head, reasons for which we have already advanced, we must, of necessity, conclude that when rotation fails, it does not do so because the pelvic floor directs the forehead from an oblique position towards the pubic

arch, but that the mechanism which is usually effective in causing this internal rotation has failed, an important factor concerned in this failure being insufficient flexion of the fœtal head.

The Author's View.

The mechanism of descent, with which internal rotation is associated, takes place in the following way:

In cases in which flexion is good the point of impact of the advancing pole of the fœtal head (vertex) occurs at the extremity of a line drawn at right angles from the centre of the plane of the brim and reaches the pelvic floor in the region of the coccyx. At the end of pregnancy the muscular fibres arising from the ischial spines and inserted into this bone and the ano-coccygeal raphe, like the whole pelvic floor musculature, are remarkably well-developed; they are, indeed, hypertrophied. Palpation reveals them as forming veritable fleshy bellies, strangely tender when vigorously pressed against, hardening on coughing and evincing complete proof of their contractile nature. It is against this part of the pelvic floor that the vertex of the well-flexed head, be the forehead posterior or anterior, first impinges, and which first resists the head's further advance. In consequence of the continued downward fœtal thrust, the result of the uterine contractions and pains, descent of the pelvic floor, beginning at this region of primary impaction, occurs; for the pelvic floor, except medianly in front where it is deficient, is attached at its circumference to the pelvic walls, and yielding, if it is to occur, must do so centrally. The coccyx becomes more sloped downwards and forwards, and instead of being placed in a superficies at right angles to the line of impact, forms an inclined plane down which the vertex is pressed. When the forehead is posterior, it is easy to understand how it falls into line behind the advancing vertex and comes to occupy the middle line posteriorly; for the transverse diameters of the pelvis become diminished whilst the antero-posterior become increased as the outlet is reached. Thus the forehead is forced towards the hollow of the sacrum by the increasing pressure between it and the postero-lateral pelvic wall, a pressure which increases progressively as descent continues.

When, however, the forehead is anterior, the mechanism of its rotation posteriorly is more difficult. Cases, as we have seen, fall into two different types—(1) in which the head is well flexed; and (2) in which the head is not well flexed. In the first group the unfavourable position is usually corrected, in the latter usually remains uncorrected.

In these cases in which the head is well flexed, just as when the forehead is posterior (and the occiput anterior), the vertex first meets the pelvic floor in the region of the coccyx, which, as before, becomes

inclined downwards and forwards and forms a plane along and down which the vertex is pressed. The vertex, therefore, is forced to occupy a lower yet more anterior position; that is, it is forced to approach the symphysis. Owing to the direction of the coccyx being continued by the ano-coccygeal raphe further descent of the vertex can only occur in conjunction with its further projection forwards (*i.e.*, towards the symphysis). This can readily occur in occipito-anterior positions, for extension of the head is possible, and now begins. But in occipito-posterior positions (the head being well flexed), such movement is resisted by the chin already being in close contact with the fœtal chest; and thus the tendency for the vertex to advance towards the pubic arch compresses the forehead in a direction obliquely upwards, with a force proportionate to the force of descent, against the upper part of the antero-lateral pelvic wall, to which it was apposed before this movement began. Descent of the forehead is prevented by the projection forwards of the vertex, which its descent along the inclined plane of the pelvic floor has determined; for the forehead can only descend in this position by causing the vertex and occiput to retreat, a movement which the pelvic floor, against which the head is forced, tends to prevent. Nor can the forehead ascend towards or above the brim, for the same force which has thrust down the vertex thrusts the fœtal chest against the chin. Since the vertex cannot further descend if the forehead remains in this position, unless considerable moulding of the head and marked recession of the pelvic floor posteriorly (coccyx and ano-coccygeal raphe) occur, and since the transverse diameter of the pelvis is greater than the antero-posterior at this (comparatively) high level in which the forehead is placed, the latter is coerced to glide into the larger transverse diameter by the resultant of those same forces which would otherwise have determined the moulding of the head by compression. This it can do, for the part of the head opposed to the floor on account of the marked flexion of the head, presents almost as a segment of a sphere, the bi-parietal diameter measuring $9\frac{1}{4}$ cm., and the suboccipito-bregmatic $9\frac{1}{2}$ cm. (see Fig. 3). The movement of the forehead into the transverse diameter of the pelvis allows the cranial axial line (see Fig. 5), about which internal rotation takes place, to advance towards the symphysis, for the forehead occupies an eccentric position in relation to it; that is to say, the distance between the forehead and the cranial axial line is greater than the distance between the side of the head and the same line. This advance or projection forwards of the upper part of the cranial axial line, and the tension of the pelvic floor below, forcing the lower part of the cranial axial line similarly forwards, determines a lessened resistance between the side of the head facing the sacrum and the posterior parts of the pelvis than exists between the forehead and the lateral pelvic wall. Thus a

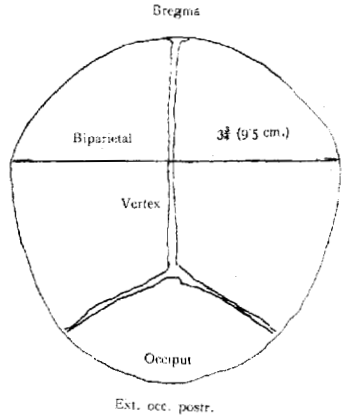

Fig. 3. Showing that the aspect of the fœtal skull, which is opposed to the pelvic floor in vertex cases, presents almost as a segment of a sphere, easily allowing internal rotation. Diagram (reduced) from Edgar's Obstetrics (p. 445). This author states the bi-parietal and suboccipito-bregmatic diameters are equal (9·5 cm.). The figures in the text (bi-parietal diam. 9¼ cm.) are those given by Bumm

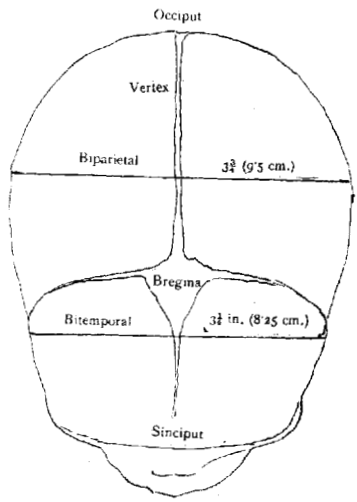

Fig. 4. Showing that the aspect of the fœtal skull, which is opposed to the pelvic floor in bregma presentations, is very far removed from a segment of a sphere, causing great difficulty in internal rotation or absolutely preventing it. Edgar gives the occipito-frontal diameter as 11·5 cm. The diagram (reduced) is from this author's obstetrics (p. 444).

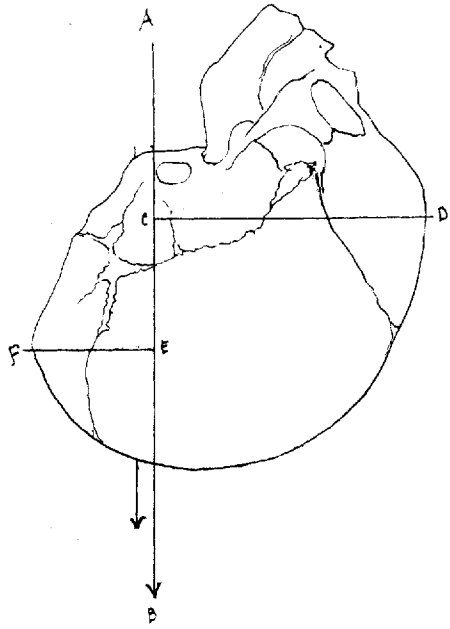

Fig. 5. Showing how the forehead is placed eccentrically to the cranial axial line. A B the cranial axial line, about which internal rotation takes place when flexion is good. When the vertex (B) is fixed by the force from above (acting along A B), the point D, coming into relation with the pelvic wall, acts as the flange of a screw.

continuance of the expelling force from above (uterine contractions) and the frictional resistance between the side wall of the pelvis and the forehead, in conjunction with a diminution of the transverse and an increase of the antero-posterior diameters of the pelvis, which occur as the region of the outlet is reached, determine a continuation of the rotatory movement so that eventually the forehead rotates into the hollow of the sacrum, whilst simultaneously the occiput turns to the front. With this screw-like rotation, descent of the head as a whole occurs, for the vertex is now able to advance and thus to descend.

That the forehead comes into such relation with the antero-lateral and later the lateral pelvic walls is shown by the following considerations : —

If a fœtal skull be taken and held in the position of extreme flexion, such as occurs in the cases in question, the line along which the driving force acts will pass from the anterior region of the foramen magnum (articular processes) to the vertex, a short way (half an inch or so) in front of the posterior fontanelle (see Fig. 5). If from this straight line, two other straight lines be drawn at right angles to it, the one passing backwards to the most distal part of the occipital bone (external occipital protuberance) (EF), and the other forwards to the most distal part of the forehead (CD), it will be found that the latter line is not only much longer than the former (more than twice as long), but is situated much higher up, *i.e.*, further away from the vertex (about $1\frac{1}{2}$ inch). Thus if equal tangential forces be applied to the extremities of these lines in planes at right angles to the axial line, *i.e.*, such as would cause a rotation, the one acting upon the forehead will have more effect in causing a rotatory movement than that acting upon the occiput, for the arm is longer. But whilst the projection of the occiput from the axial line is not greater than the other parts of the fœtal head at this low level, that of the forehead is maximal; the region of the vertex is approximately hemispherical, but the forehead is placed eccentrically to the axial line along which the force of descent acts, and its most distal centrifugal part acts as the flange of a screw.

For the screw-like rotation to occur it is no less necessary that whilst the advancing pole of the head be fixed and another part be placed eccentrically, that the pelvis also must be so shaped that when the well-flexed head is passed through it and its advancing pole is fixed, that its eccentric part should so come into relation with the lateral wall that it may be forced to glide circumferentially around it. This condition obtains in the normal female pelvis in which the transverse diameter of the brim is greater than the antero-lateral.

That the shape of the maternal pelvis is a necessary factor in causing this rotation is shown by the failure of this mechanism of

rotation to occur in cases in which the transverse diameter of the pelvis, near or at the brim, is not greater than the oblique, as is found in the small round pelvis (Herman [23]). In these cases the posterior position of the occiput persists, and the persistence occurs in spite of good flexion of the head. The reason of this is to be found in the fact that compression from above (uterine contraction) cannot produce tangential forces between the forehead and pelvic wall. The kyphotic pelvis is also stated (Edgar, *ibid*, p. 579) to be a cause of persistence of the occiput behind. In this variety of pelvis, the transverse diameter at the brim is not altered, or only slightly increased, but the conjugate at the brim may be considerably lengthened; so that the relation of these two diameters to each other is similar to that found in the small round pelvis, or the condition in the normal is actually reversed.

When, however, the head is not well flexed the same mechanism cannot occur. In this case, the part of the head that reaches the floor first is not the vertex, but an area much nearer the anterior fontanelle—bregma presentation. The forehead being much lower in the pelvis than when flexion is good, the occiput of necessity must be situated more posteriorly in the oblique diameter (*i.e.*, nearer the pelvic wall), and the pelvis being basin-like in shape (*i.e.*, the floor being a concavity and not a plane), the occiput must be higher up (*i.e.*, nearer the brim) than when flexion is good. As the fœtus is pressed downwards, the anterior inter-parietal region cannot so easily cause descent of the floor, because it is more obtuse than the vertex, and its descent is resisted by a correspondingly larger area of the pelvic floor. Descent, indeed, can only occur by the moulding which results from the approximation of the forehead to the occiput, and which occurs in consequence of the reflection of the impulses from the resistance of the lateral pelvic walls set up by the force of descent. The coccyx does not so readily form an inclined plane, can indeed only do so as the result of the descent of the head which the moulding makes possible; and the advancing pole of the head cannot, until considerably moulded, be pressed along it; for its advance is prevented by the apposition of the forehead against the *lower part* of the antero-lateral pelvic wall. Hence descent can only occur in conjunction with marked recession of the coccyx and the ano-coccygeal raphe. Moreover, it is to be noted that this part of the antero-lateral pelvic wall is here padded by the thick internal obturator muscle, which certainly will contract with the other leg muscles during the straining, and thus encroach on the already limited space. Nor can the lateral movement of the forehead so readily, or indeed at all, occur: because the transverse diameter of the pelvis at this level is less than that higher up; and further, because the diameters of the fœtal head concerned in such rotation are the bi-parietal $9\frac{1}{4}$ cm .as before, but the sub-occipito-bregmatic $9\frac{1}{2}$ cm. is replaced by the occipito-

frontal, 12 cm. (see Fig. 4). As a result of the continued onward pressure and the moulding of the head, the pelvic floor in its descent before the advancing head, becomes deepened by the exaggerated recession of the coccyx and its raphe, and being deficient anteriorly where the aperture exists, through which the presenting part of the head now projects, more space is available in the sagittal plane. Into this plane, therefore, the head is pressed, for a corresponding increase laterally cannot occur. In this position, when the head is of average size, delivery can only be accomplished by much moulding. The forehead becomes jammed against the symphysis, and the occiput slowly passes over the posterior commissure of the pubo-rectalis muscle and the superficial perineal parts. When it is born, the nape of the neck occupies the vulvar cleft posteriorly and the forehead is then pressed down past the symphysis and so the face appears and the head is delivered.

Thus the change from the occipito-posterior to the occipito-anterior position appears to be the result, not so much of the occiput being rotated forwards, as of the forehead being rotated backwards. The vertex, in the depths of the pelvis, is pinned against the pelvic floor by the force from above, and is comparatively fixed: it certainly is extremely difficult to impart any degree of rotation to it manually during a pain. The change from the one position to the other does indeed necessitate a rotation of the vertex, through which the axis of rotation, like that of descent, passes; but during this movement, which is much like a ball rotating within a closely-fitting cup, its excursion is small and is limited to its further descent and projection forwards in the sagittal plane, which the change in the position of the forehead allows: for descent and rotation are synchronous movements. The forehead, on the other hand, when the head is well flexed, has considerable excursive capabilities, being able to sweep around the pelvic wall to which it is apposed, from its primary antero-lateral position into the hollow of the sacrum. As the vertex, approximately maintaining its position in the sagittal plane, descends along the inclination into which the pelvic floor posteriorly is transformed by its passage, this circular sweep of the forehead is also accompanied by a movement of descent and is truly a screw-like rotation.

Since the pelvic floor maintains the vertex fixed centrally, and is the point d'appui around which rotation occurs, it plays an essential part in rotation. If the vertex met no resistance below it would deviate laterally and backwards, and the forehead instead of rotating would merely descend. This is what actually happened in Dubois' and Edgar's terminal experiments: the absence of sufficient resistance, *i.e.*, of central fixation, explains the failure of the head to rotate. Normally, however, the pelvic floor opposes the descent of the vertex with a force proportionate to, and caused by, the force determining

descent (uterine and abdominal wall contractions), thereby fixing it, and consequently the several forces reacting between the circumferential parts of the lower fœtal pole (head) and the pelvic walls with which they are in contact, come into play. When this factor is not present, as when the fœtal head is considerably smaller than the pelvic cavity or when it is not well flexed, or the pelvic diameters are approximately equal, this reaction of forces between the forehead and the pelvic wall cannot occur and internal rotation is not produced, the head being born in an oblique or transverse position.

Finally, these forces cannot come into play in the absence of a driving force: hence uterine activity is essential.

Thus the factors concerned in causing rotation are: (1) the expulsive force from above; (2) the obstructing, central fixing, force from below; (3) the shape of the pelvis; (4) the shape, size, consistence and position (flexion) of the fœtal head.

REFERENCES.

1. *Ould.* "A Treatise of Midwifery." 1742. p. 28.
2. Smellie's "Midwifery," Ed. by McClintock. 1876. Vol. i, p. 96.
3. Saxtorph. ("Theoria de diverso partu ob diversum capitis ad pelvina relationem mutuam experimentia fundata." 1772.) Quoted from Leishman.
4. Solayres de Renhac. Quoted from Leishman.
5. Schmitt. "Geburtshülfliche Fragmente." Wein, 1804. Quoted from Leishman and Naegele.
6. Naegele. "Ueber den Mechanismus der Geburt." *Deutsches Archiv für die Physiologie.* Meckel. Band v, p. 483—531. 1819.
7. Leishman. "An Essay, Historical and Critical, on the Mechanism of Parturition." 1864. p. 75.
8. Veit. "Die Anatomie des Beckens im Hinblick auf den Mech. d. Geb." 1887.
9. Varnier. "Du Detroit Inférieur Musculaire du Basin Obstetrical," Paris, 1888. Quoted from W. Williams and Edgar.
10. Whitridge Williams. "Obstetrics." 1908, p. 261.
11. Dubois. Quoted from Whitridge Williams, *ibid.*
12. Edgar. "Practice of Obstetrics." 1903. p. 477
13. Amand Routh. "Parturition during Paraplegia." *Obstet. Trans.*, London. Vol. xxxix, 1897. p. 197.
14. Olshausen, in "Karl Schroeder's Lehrbuch der Geburtshülfe, Elfte Auflage neu bearbeitet von R. Olshausen u. J. Veit." 1891. p. 194.
15. Olshausen. "Beitrag zur Lehre vom Mech. der Geburt." 1901.
16. Bumm. "Grundriss zum Studium der Geburtshulfe." 1905. p. 206.
17. Hugo Sellheim. "Die Beziehungen des Geburtskanales und des Geburtsobjektes zur Geburtsmechanik." *Beiträge zur Geburtshilfe und Gynäkologie,* Hegar 11th, Band, 1906, p. 1.
18. Olshausen. "Zur Lehre vom Geburtsmechanismus." *Zentralb. f. Gyn.,* 1906, p. 1113—1119.
19. Barbour. "The Anatomy of Labour and its Clinical Bearing." 1889, p. 43.
20. Barbour. "Atlas of the Anatomy of Labour." 1889. Plate IV, Fig. 1.
21. R. U. West. "Cranial Presentations." *Glasgow Medical Journal,* October 1856. p. 290, *et seq.*
22. Herman. "Difficult Labour." 1901. p. 190.
23. Herman. *Ibid.* p. 141.