reaction. Later on an injection of the same brew of vaccine that was used in the series of prophylactic vaccinations now under consideration was introduced into the opposite flank. This was followed by a precisely similar train of events, although on this occasion the symptoms were distinctly less severe; the agglutination response on this occasion rose to 1 in 40.

The subjects.—*Naval.*—Of the staff of the Naval Hospital at Bighi 43 men were available for observation in this connexion, of whom 23 were vaccinated (seven on one occasion only and 16 on two occasions) and 20 were reserved as controls. From the 23 vaccinated men, however, two must be deducted, for the danger that must always exist in carrying out a series of vaccinations within the endemic area was here encountered and two of the men were vaccinated—each with a dose of 200,000,000 cocci—during the incubation period of the naturally acquired disease. This leaves 21 inoculated men and 20 controls who were under observation from April 27th to August 30th, 1906. During this period one of the controls contracted the disease, but no cases occurred amongst the vaccinated men.

Military.—The strength of the Valetta detachment of the Royal Army Medical Corps at the commencement of the experiment comprised 84 men, of whom 12 had already suffered from an attack of "Malta fever" and four were then in hospital. This left a balance of 68 available for the purposes of observation. Of these 30 volunteered for inoculation; the remaining 38 served as controls. The fallacies involved in such a division have already been threshed out in connexion with prophylactic inoculations of typhoid vaccine, and need not be further enlarged upon here. Suffice to say, that of the inoculated men 15 received one injection only and 15 received two injections; and during the four months from April 26th to August 30th, 1906, two cases occurred amongst the non-vaccinated controls and none in the vaccinated men. At the beginning of September, however, after I left Malta, two cases occurred in the vaccinated men. The first, a lance-corporal, an assistant in the Commission Laboratory at Valetta, who had been injected twice with a dose of 400,000,000 cocci on each occasion and whose serum value had reached 1 in 50, suffered a typical attack, and the second, a private, who had been inoculated once only with a similar dose and whose serum had a value of 1 in 30. In this series of inoculations it was noted that the response of the individual as judged by the movements of the agglutination value of the serum varied within wide limits from a positive reaction in a dilution of 1 in 200 to a negative reaction in a dilution of 1 in 5 as a result of the first injection. A further point was the very distinct fall in the titre of the serum that has taken place by the end of the four months, in one case from 1 in 200 to 1 in 10, showing that the individual response to vaccination, so far as relates to the production of antibodies of the agglutinin group, at any rate, is limited to a comparatively short period, and apparently indicates that a further inoculation is necessary at the end of about three months after the first or second. The immunity of the inoculated men during a period of four months from any attack of Melitensis septicaemia, though possibly due in part to the elimination of the "goat's milk" factor, also indicates to my mind that prophylactic inoculations have a distinct value.

Anti-serum.—In 1895 Wright infected goats and in 1896 a horse was inoculated with *Micrococcus melitensis* in the attempt to produce an anti-serum, and about 50 cases seem to have been treated with the serum from the horse (Aldridge, Fitzgerald, and Ewart), but the published cases do not offer any very convincing evidence of the value of such serum. In connexion with the use of serum a word of warning is necessary, as in the immunisation of both goat and horse I have noted that after the injection of living cultures the cocci are present in the blood from four to six weeks, and if the animal is bled during this period living cocci can be demonstrated in the serum by inoculating some 10 to 20 cubic centimetres subcutaneously into the guinea-pig. In the case of a horse which had been treated for a period of 11 months, with first dead and subsequently living cultures of *micrococcus Melitensis*, 0.1 cubic centimetre of the serum (which had an agglutinating value of 1 in 1500) was found to protect when injected simultaneously into the cerebral tissue of the guinea-pig against some ten lethal doses, but even 10 or 20 cubic centimetres of serum injected subcutaneously failed to protect against an identical dose of the virus injected into the brain.

The action of the serum was also tested upon monkeys

previously injected subcutaneously with 0.1 loopful of cultivation of *micrococcus Melitensis* emulsified in one cubic centimetre of normal saline solution. Eight days later, when signs of successful infection—rise of temperature, appearance of agglutinins in blood, &c.—were apparent, two were set aside for observation as controls; three others each received three cubic centimetres of horse serum subcutaneously daily for eight days and a fourth received three cubic centimetres of horse serum injected directly into the external saphenous vein daily for a similar period. The result was by no means encouraging, for while one of the monkeys showed a comparatively even temperature and an absence of marked pyrexia that might be attributed to the action of the serum, the charts of the remaining three serum-treated monkeys showed no mark differences, so far as concerns the range and duration of pyrexia, from those of the two controls, while throughout the course of the experiment simple visual observation of the infected animals was insufficient to enable one to distinguish between those treated with serum and the controls. Whilst in Malta I was only able to obtain permission to administer serum to one human case, but beyond steadying the pulse and bringing it down from 108 to 96 per minute, a result which, in my own opinion, might equally well have been achieved by a simple injection of normal saline solution, no further effect could be detected.

A Clinical Lecture

ON

CONGENITAL DISLOCATION OF THE HIP AND ITS TREATMENT.

Delivered at the Hospital for Sick Children, Great Ormond-street, on Dec. 12th, 1907,

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LADIES AND GENTLEMEN,—I do not think I need apologise for making congenital dislocation of the hip the subject of my lecture to-day, as the frequency of its occurrence warrants us in paying considerable attention to its pathology and treatment. The work of Paci, Hoffa, Lorenz, and others has given us a sound knowledge of the morbid anatomy of the deformity and enabled us to treat it with considerable success. Let me first remind you of some facts relating to its occurrence before passing on to its pathological anatomy, a knowledge of which is essential if our treatment is to be scientific and successful.

Congenital dislocation of the hip is far commoner in females than males; Young has collected figures from various sources and gives 3113 cases, with 456, or 14 per cent. in males, and 2657, or 86 per cent. in females—i.e., about one male to six females. Two-thirds of the cases in this series were unilateral and one-third bilateral. When unilateral the left hip is slightly more frequently affected than the right. Young gives 637 right and 799 left.

The etiology of this deformity need not detain us for long. We may admit at once that the cause is unknown. That heredity sometimes plays a part is shown by the numerous instances reported of the deformity occurring in more than one member of a family. Dupuytren mentions the case of a girl who had eight relatives similarly affected. As to the preponderance of females over males affected, the former are said to be more prone to deformities of all kinds. Heusner and Marcwald found that the capsule of the hip-joint was more lax in female than in male fetuses. That arrest or defect of development is the essential factor in the majority of cases, whether traumatism in utero or at birth plays a part or not, is, I think, proved by the frequency with which imperfect development of the pelvis and often of all the bones of the leg accompanies the dislocation, to which further reference will be made later.

PATHOLOGICAL ANATOMY.

The condition of the joint will be found to vary according to the age of the case; the older the child the greater the alteration found in all the structures composing the joint.

In infants the difference from the normal is slight, though one change, and that the most important in this deformity at all ages, is always present, and that is a want of development of the upper lip of the acetabulum. So far as the bony margin is concerned this poorness of the upper lip of the acetabulum is shown in x-ray photographs of two of my cases, aged respectively 18 and 19 months. The acetabulum is at first circular and perhaps a little shallow. The capsule is thin and somewhat distended by a slight excess of fluid. The pelvis on the affected side shows some general want of development and distortion. The femur is normal; the ligamentum teres is rarely absent. After walking has commenced the changes in the bones get progressively more marked. The acetabulum gradually becomes triangular in outline, with the apex upwards and backwards, where the margin of the cavity is imperfectly developed and where the true and the false joint cavities join. The capsule is now thickened as a result of nature's effort to resist further migration of the head of the femur. The thickening is most marked in the lower and anterior parts of the capsule, while it also includes the Y ligament. Another change in the capsule, the importance of which was emphasised by Burghard in 1901, is the so-called "hour-glass contraction." This contraction takes place at the junction of the lower part of the joint cavity, formed by the acetabulum and the lower part of the capsule which covers it like a lid, and the upper part formed entirely of capsule surrounding the displaced head of the femur. This constriction is crossed, and perhaps increased, by the ilio-psoas tendon. When the upper part of the capsule is opened a slit-like opening into the acetabular part of the joint is seen; this has been aptly likened to the pockets often seen inside a brougham. It is the small size of this opening as compared with the head of the femur that constitutes one of the chief difficulties in reduction of the dislocation. The upper part of the capsule i.e., the part surrounding the head of the femur, becomes blended with the periosteum of the dorsum ilii, where a new socket may eventually be formed, but this is rarely developed to any great extent before adult life. The condition of the ligamentum teres may be briefly referred to but is of no practical importance. Suffice it to say that in the younger children it is rarely absent, whereas in the older children it is commonly absent, and when present it is thin and flat. The femur is often well formed, the most obvious thing about it being the size of its head, which is disproportionately large as compared with the acetabulum; but, as will be shown later, the upper end of the bone is almost invariably imperfectly ossified as compared with the bone of the opposite side. The head is flattened on its posterior and lower aspect and this flattening increases as the child grows, till, with the formation of new bone around the point of pressure, the head becomes mushroom-shaped. This flattening is seen in this specimen from the Charing Cross Hospital Museum; the acetabulum will be noticed to be triangular. The acetabulum is always present at birth and its obliteration later, when the dislocation is left unreduced, would seem to be a matter of extreme rarity. In this connexion I may refer to two specimens. The first is in the Museum of the Royal College of Surgeons of England (No. 1766A) and is that of the pelvis and parts of the femora of a woman, aged 60 years, the subject of bilateral congenital dislocation of the hip. The case had been described nearly 40 years before her death by Carnochan as a congenital case. There is a definite acetabulum on both sides. The other specimen is that of a bilateral case in which the acetabulum on both sides is replaced by a bony projection. Wax models of the two joints in this case were presented to St. Mary's Hospital Museum by Mr. Stansfield Collier, who saw the specimen in the Dupuytren Museum in Paris and kindly told me about it. Rarely the head and neck degenerate into a mere conical process and may even be entirely absorbed. The neck is often short, and may be depressed, producing the condition called coxa vara, but this is, I believe, by no means common, while an opposite condition, coxa valga, may occasionally be present. A far more common occurrence—in fact, it might be said to be always present to a slight degree—is an increase of the angle made by the axis of the neck of the bone with the transcondylar line, what is usually called "anteversion" of the neck of the femur. When the leg is placed with the patella looking forwards and the transcondylar line transverse, the neck of the femur is normally directed inwards, upwards, and slightly forwards. In a case of congenital dislocation with the leg in the same position, the neck of the femur may point nearly or even directly forwards. According to Lange the

twist takes place in the upper part of the shaft, the whole of the upper extremity being turned forwards. The degree of anteversion present is considered by many to determine whether the result of operative treatment shall be completely or only partially successful. The shaft of the bone is usually thinner on the side of the dislocation and may be shorter.

The pelvic deformity, apart from the changes in the acetabulum, is not of much practical importance, as even in bilateral cases little, if any, obstruction to delivery is offered during labour. I should like, however, to emphasise the fact that the pelvis on the side of the dislocation almost invariably shows signs of imperfect development and ossification, and this occurs, as already stated, even in infants, showing that the deformity is not by any means limited to the hip-joint itself, but usually involves half the pelvis and sometimes the whole lower limb. Owing to the kindness of my colleagues on the staff of this hospital I have been able to examine the x ray photographs of their cases as well as those of my own. The photographs have been taken by Dr. Morton W. Smart and Dr. W. Ironside Bruce, a former and the present radiographer to the hospital respectively. To Dr. Bruce, who has also photographed my cases at Charing Cross Hospital, I wish to offer my sincere thanks for the care and trouble which he has taken in providing me with radiographs of the cases during and after treatment. I have been able to note the details of the skiagraphic appearances in nearly a hundred cases (94), of which 67 were unilateral. The appearances in typical unilateral cases is shown in this skiagram (Figs. 1 and 2). The os innominatum on the affected side is slightly smaller from top to bottom than the other (65 per cent. of the cases), and the conjoint rami of the pubis and ischium show imperfect ossification (92 per cent.). This delay in ossification usually shows itself as an increase in length of the piece of unossified cartilage between the two rami, but when the cartilaginous interval has disappeared the conjoint rami are thinner and more transparent than those of the opposite bone. The acetabular outline is less definite and the upper lip is more feebly developed. (Occasionally the upper lip is fairly well developed; this was so in 16 per cent. of the plates examined, but very rarely are the two acetabula symmetrical.) The ossific centre for the head of the femur is small as compared with the other (83 per cent.), and this is often true of the centre for the great trochanter. The head lies almost in the line of the shaft of the bone. The whole upper end of the bone is less dense than the other and the shaft of the bone is thinner; this last was observed in 68.6 per cent. Of the anteversion of the neck of the femur it is impossible to speak from an examination of skiagraphs, as the position of the leg at the time the photograph was taken is known in but a few of the cases. The skiagraph should be taken with the patellæ directed forwards, or better still, two plates should be taken, one as above and the other with the legs inverted. I am well aware of the difficulties attending the reading of skiagraphs, but I feel sure that most of the above conclusions would be verified by dissection. The measurement of the pelvic bone from above down could certainly be altered by the tilt of the bone, but the conjoint rami are certainly not altered in direction sufficiently to explain the appearances seen. The general clearness of the bones on the affected side could not, I think, be entirely explained by difference in the relative position of the sensitive plate on the two sides. Definite coxa vara was only seen twice and coxa valga three times; coxa vara of the other femur was noted in three plates, coxa valga in two. In one case the shaft of the dislocated femur was thicker than that of the other.

Bilateral cases show similar changes, though these are naturally not so obvious in the absence of a normal side for comparison. Not often are the two sides absolutely symmetrical. The head of one femur is more displaced or anteversion is more marked on one side. In 27 plates of bilateral cases obvious asymmetry of the acetabula was noted only twice and a difference in the size of the shafts of the femora six times. Of these six cases in three the left femur was the thinner of the two, and in one the right, and in the remaining two the side could not be determined. Of these 94 cases, all of which were below the age of 12 and the majority below the age of eight, in only three of the unilateral and four of the bilateral did the x rays show any signs of the formation of a new socket.

As to the muscles around the joint it must be remembered that few consist of parallel running fibres, but that in the majority the fibres radiate. Take the adductor magnus, for

instance. The upper fibres of this muscle are horizontal, the lower nearly vertical; in congenital dislocation the former are lengthened, the latter shortened (Jackson Clarke). But we have only to think of the short fibres, as these alone will offer resistance to reduction; so for practical purposes a muscle of which some of the fibres are short may be reckoned as being a short muscle. The short muscles are the adductors, hamstrings, psoas and iliacus, rectus femoris, and tensor fasciæ femoris. The obturators and gemelli are lengthened. Some fibres of the glutei are shortened, therefore they may be considered as short muscles.

The head of the femur may be displaced upwards and backwards, or upwards and forwards, or forwards only. The first is by far the most common variety; at first the displacement is chiefly upwards, but later backwards as well. The second variety, the subspinous variety, is rare; I have observed it only once in 53 cases; and the last, the pubic form, is excessively rare. As a rule there is no other gross deformity in a patient with congenital dislocation of the hip. A general laxity of ligaments may be present, and occasionally a number of other deformities. Among 53 cases I have found two with genu recurvatum, one with genu valgum, four with talipes valgus, one with hemiplegia, and one with cleft palate. In two cases, both bilateral, several congenital deformities were present; one had double genu valgum with rigid knees, double talipes calcaneo-valgus, and double inguinal hernia; the other had hydrocephalus, spina bifida, paralysis of the legs with rigidity of the knees, and double talipes equino-valgus.

SIGNS AND SYMPTOMS.

The general rule that nothing wrong is noticed till the child begins to walk is not absolute, as occasionally the parents notice something wrong with the position or shape of the leg soon after birth; in one of my cases the parents noticed the deformity when the child was only two weeks old. When walking is commenced the child is noticed to limp, and this limp gets progressively worse. Usually the child puts the heel to the ground and sways over the hip as she leans her weight on it in a characteristic manner; occasionally only does she make up for the shortening by walking on her toes. In one of my cases the child seemed afraid of trusting to the short leg and hurriedly came down on the foot of the normal leg with a thud. These children get tired easily; and as they get older undoubtedly suffer from pain in the affected joint. On stripping the child the difference in the contour of the two sides in the region of the trochanters is at once obvious. The buttock is flat and the whole thigh may be a trifle thinner than the other. Lordosis is only present in unilateral cases in the older children and then never to the extent seen when the deformity is bilateral. On laying the patient on a couch the leg is noticed to be short; a tape may show this to amount to anything from one-half to two inches in children under 12 years of age. The trochanter is displaced upwards and usually backwards. The best way to estimate the relative positions of the trochanters is to stand on one side of the patient, facing the head of the couch, and to place the two thumbs on the anterior superior iliac spines and to feel the trochanters with the tips of the first and second fingers. If one cannot be sure of any difference between the two sides by the use of the hands alone, and it is only in the younger and fatter children that there is any difficulty, I doubt whether Nélaton's or any other line is likely to be of assistance. I hardly ever make use of Nélaton's line in children. An abnormal hollow can sometimes be seen, and always felt, in Scarpa's triangle over the position which the head of the femur ought to occupy. There is often a concavity on the inner side of the thigh just below the pubes and asymmetry of the groove between the labium and thigh. In bilateral cases there is a gap between the upper parts of the thighs. A slight fulness can often be seen below and to the outer side of the anterior superior spine. The fingers or thumb will feel an undue resistance at this spot. The swelling and resistance are caused by the misplaced head of the femur, and in the majority of cases this is felt at the spot indicated—namely, below and to the outer side of the anterior superior iliac spine and in front of the great trochanter. The position of the head may be verified by placing the fingers and thumb of one hand over the great trochanter and head respectively, while the leg is gently rotated out and in with the other hand. The head of the bone will be felt to impinge upon and thrust out the thumb as the femur is everted. On this

the diagnosis practically depends. In older children and in those with a great deal of shortening the head may be on a level with or even above the level of the anterior superior spine. Do not imagine that the older children with a larger amount of shortening necessarily have the greater amount of displacement of the femur. This is not by any means invariably the case. A big child may have from an inch to one and a half inches of shortening and yet the head of the femur be only just above the level of the acetabulum, some of the shortening being due to the bones, and *vice versa* a young child with even less shortening may have more displacement of the bones. There seems to be no obvious reason why in one case the displacement should become progressively greater and in another remain almost stationary, unless it be that the power to thicken the capsule and resist further displacement depends upon the general health and muscular tone of the sufferer.

To return to the signs of this deformity, the movements of the limb are free, smooth, and painless, and are sometimes too free, but are more commonly limited in one or more directions, particularly if an unsuccessful attempt at reduction has been made some months previously. The two directions in which movement is commonly limited are abduction and internal rotation. In more than half my cases abduction was more or less limited; in 22 out of 39 unilateral cases. In 10 cases internal rotation was limited, in most of these only to a slight degree, but in some to a marked extent. In one only was external rotation limited. This was in a girl aged seven years in whom the leg was inverted, and both internal and external rotation were limited; abduction was only slightly limited; the shortening amounted to one and one-eighth inches; and the case had had no treatment.

The last sign I wish to refer to is what is usually described as "telescopic movement." Great stress has been laid on the importance of this sign, but I venture to think that it is more difficult to make sure of and therefore less reliable than that of feeling the head of the femur in its abnormal position. It is, however, a valuable confirmatory sign and one which should always be examined for. This undue mobility of the femur on the pelvis in a downward and upward direction tends to become restricted as the displacement increases. It can be entirely destroyed by voluntary effort on the part of the patient and is always most marked when the child is anæsthetised.

In bilateral cases the symptoms and signs are similar and in most cases more marked. The gait is, of course, worse and is quite characteristic. The trochanters can sometimes be seen moving backwards and forwards as the child walks. In some the pelvis is held remarkably steady and horizontal while the swaying all takes place in the lumbar spine. As stated above in reference to the x ray appearances the deformity is rarely symmetrical. Of 13 bilateral cases nine showed asymmetry. In six the left leg was the shorter of the two, in three the right. The shortening varied from one-eighth to five-eighths of an inch.

Lordosis is usually present, often to a marked degree, though it may be but slight even in older children. I found it slightly marked in two children of eight and nine years of age respectively. Abduction and internal rotation are both more likely to be limited in bilateral than in unilateral cases.

There seems no doubt but that, as a rule, the deformity is more severe and the changes in the bones and soft parts are more marked in bilateral than in unilateral cases. The difficulty in walking and the disfigurement are undoubtedly much greater in the bilateral cases. Before passing on to discuss the treatment it would be as well to consider for a moment what is the fate of these cases if left untreated.

Are we justified in operating upon these cases? We can safely answer this in the affirmative and say that we are justified in endeavouring to cure these patients because, as I hope to prove to you later, we can offer them a fair prospect of cure and almost certain amelioration. It is not often that one comes across an adult with congenital dislocation of the hip, so one is obliged to try to form an unbiased opinion from the writings of others. After fairly extensive reading I feel convinced that in the vast majority of cases the deformity is a very real handicap to the sufferer. The shortening and other signs increase during adolescence and then often the progress is checked and the joint becomes firmer as a new acetabulum is formed. The ungainly gait persists and the patient is troubled with attacks of pain in the joint, often necessitating retirement to bed, no doubt due to arthritic changes in the new joint. A bilateral case

FIG. 1.—Unilateral dislocation in a girl, aged two years and eight months. Note the size of the centre for the head of the femur, the thinness of the shaft, the imperfect acetabulum, and the imperfect ossification of the conjoint rami.

FIG. 2.—Unilateral dislocation in a girl, aged seven years. Note the imperfect development of the head of the dislocated femur, the flattening of the head, the small size of the trochanteric centre, the thinness of the shaft, the thinness of the conjoint rami, the feeble upper lip of the acetabulum, and the transparency of the bones on the side of the dislocation.

FIG. 3.—Unilateral dislocation in a girl, aged four years, two days after reduction by Lorenz's method. The joint itself is not covered by the plaster cast, the limits of which are distinctly seen at *p p*.

FIG. 4.—Appearances nearly five years after reduction of the left hip by Lorenz's method. Girl aged four years at time of operation (January, 1903). The legs are now equal in length, though the left shaft is much thinner than the right, as could be seen in the lower part of the skiagram, not reproduced.

FIG. 5.—Skiagram taken four and a half years after reduction of the left hip by Lorenz's method. Operation April, 1903. Girl aged nearly three years at time of operation. The legs are now equal in length.

FIG. 6.—Skiagram taken three and a half years after reduction of the right hip by Lorenz's method. Operation April, 1904. Girl aged three years at time of operation. The right leg is the longer of the two, the left having become partially paralysed.

may be so crippled that she cannot get about without crutches.

TREATMENT.

In children there are two methods of treatment in vogue at the present time. One is the so-called bloodless or manipulative method and the other is reduction by means of an open operation, while a reduction may be effected by a combination of the two. The bloodless method is usually associated with the name of Lorenz and below it will be referred to as the Lorenz method. Of the open method there are two varieties, the Hoffa-Lorenz operation, in which the bones are attacked and an attempt made to improve the size and shape of the acetabulum, and the method practised and described by Burghard and in which the joint is opened, the hour-glass contraction dilated, and the head of the femur placed in the acetabulum beneath the eye, no attempt being made to improve the shape of the bones. Burghard, while not denying the use of the manipulative method in "quite young children," advises that after five it should be supplemented by an open operation a week later.

The Hoffa-Lorenz open operation is now pretty generally condemned on account of the risk of ankylosis occurring. Whether we follow Lorenz or Burghard we endeavour to place the head of the femur in contact with the acetabulum and to keep it there by fixing the limb in a suitable abnormal position for a length of time sufficient to allow the parts around the joint to consolidate, so that when the limb is allowed gradually to assume its normal position redislocation does not occur.

It is, of course, essential that a true anatomical reduction should be obtained at the time of operation but it is no less essential that the limb should be fixed in plaster-of-Paris for a sufficient length of time afterwards, six months at least, if a permanent successful result is to be obtained. In the out-patient department I have come across a fair number of cases which had been previously submitted to operation by various surgeons in various hospitals and I feel convinced that many of the unsuccessful operations owe their failure to the fact that the limb has been brought down parallel to the other too soon. Too often a successful operation has been wasted for want of proper after-treatment. It does not matter what method of reduction has been made use of, the joint must be given time to consolidate. If the bones have not been damaged there need be no fear of ankylosis occurring. Much has been written on the relative dangers of the two operations. There are special dangers attached to both methods, of which more will be said later. Suffice it to say that in the Lorenz method the danger lies in the great force which has often to be exerted in order to tear or stretch the structures which oppose reduction, while in the open method there is the risk of sepsis. However careful the surgeon may be there is always a greater risk attaching to this operation than to most other "clean" operations. The reason for this lies in the fact that there is always a good deal of laceration of tissues and effusion of blood as a result, while the forcible manipulations performed while the wound is open must necessarily increase the chance of the sterilised towels slipping and allowing the wound to be contaminated. The open operation does not do away with the necessity for using force to produce the reduction; in fact, the Lorenz manipulations with their accompanying dangers have to be added to the risk of sepsis. While I have only performed the "open" operation in one case I have had the opportunity of seeing it performed on several occasions by others and I feel convinced that the above statement is correct for the majority, if not for all cases, excepting the youngest children, for whom the Lorenz operation is admittedly preferable. Burghard diminishes the manipulations necessary at the time the joint is opened by anæsthetising the patient a week previously and manipulating the limb after the method of Lorenz, or, in other words, he tries the Lorenz method first, and if that fails he opens the joint a week later. This course somewhat modified is the one I have adopted in treating the cases that have come to my hands, though I differ from Burghard in the number in which I consider the second operation necessary. I believe that in the great majority of cases at all ages up to, say, 12 years, perhaps more, reduction can be obtained by manipulation alone and that in these the chance of obtaining a permanent cure is as good as, if not better than, it would be had they been opened. If the capsule is folded down between the femur and the acetabulum the condition may be suspected by the extreme instability of the reduced head at the time of

the operation and a skiagraph will show the head of the femur riding on the upper lip of the acetabulum. In a case of this kind, if Lorenz's method has been thoroughly carried out, the manipulations will have been vigorous and prolonged and the resulting bruising around the joint will be considerable, so I should prefer to wait three weeks rather than one before opening the joint. I consider it essential that during this three weeks the leg should be fixed in the Lorenz or frog position, with the knee well back, so that the manipulations required at the second operation may be of the slightest.

The one case in which I performed the open operation came under my care as the result of the illness of one of my senior colleagues who had performed a Lorenz operation a few days previously, but the head of the femur would not remain opposite the acetabulum. The leg was kept in plaster for about three weeks and then the joint was opened, the leg being still abducted at a right angle. An anterior incision was made approximately in the usual line for excision of the joint, and the capsule opened in the same line from acetabulum to femur, the innermost part of the Y ligament being divided. The capsule was found to be contracted all round the acetabular margin, as much above as below, but the lower part was, in addition, held over the acetabulum by the ilio-psoas tendon. This was freed from the lesser trochanter and the dislocation reduced. Some difficulty was experienced in obtaining the full hyper-extension, and in forcing the knee back the head of the bone was dislocated forwards through the slit in the capsule. This was at once reduced and the leg fixed with the lower end of the femur only slightly behind the plane of the upper. The capsule was not sutured as there was no tendency to recurrence of the forward dislocation and the wound was closed. Healing took place by first intention and a skiagraph taken with the leg in plaster two or three days after the operation showed the bones in excellent position. The case was operated upon a year ago and when seen two months ago with Dr. E. R. Hunt of Brighton, under whose care she is, there was every prospect of a permanent cure resulting.¹

Burghard lays stress on the importance of dividing the ilio-psoas, which he usually does obliquely with a pair of scissors. As to opening the capsule, he says the "exact method of incising the capsule is not of much importance: latterly I have made it parallel to the long axis of the neck of the femur and over the head of the bone made prominent by rotating the limb outwards. This has the advantage that the incision is in the lax portion of the capsule and allows the thickened anterior portion lying over the acetabulum to be more easily defined. It is this latter portion of the capsule that offers the greatest obstacle to reduction; the finger passed through the narrow slit-like opening between it and the upper edge of the acetabulum will ascertain whether there is room for the head to pass into position, and if not a way must be made for it by detaching the capsule from the acetabular rim sufficiently to allow of its passage. It is always well, however, not to detach the capsule too freely from the rim of the acetabulum as the various bands in that situation are powerful agents in preventing the head of the bone from slipping out of place. No attempt whatever is made to deepen the acetabulum or to shape the head of the bone afresh."

Openshaw in 1903 recommended a combined method but his open operation included deepening of the acetabulum.

We may now discuss the details of the Lorenz or "bloodless method." By its use we can obtain an anatomical reduction in the majority of cases and in the greater number of these the reduction will be permanent.

In making these statements I have the support of Jackson Clarke who has been a strong supporter of this method of treatment since Lorenz visited London in January, 1903. In children over the age of 12 years the method may possibly result in an anatomical cure and in many cases will give a good functional result.

Of my cases 40 have been operated upon by the Lorenz method, in most cases by myself and in a few by a member of the resident staff of this or Charing Cross Hospital under my direction. The ages of the patients at the time of operation varied from 19 months to just under 11 years. Of these

¹ This case was seen again six months later and the hip was by no means satisfactory. The head of the femur subluxated forwards as the child walked with the leg markedly everted. There seemed to be no tendency for it to pass upwards. It was hoped that even now a good result might be obtained by inverting the limb and applying a plaster case.

40 the dislocation was unilateral in 31, bilateral in the remainder. Of the 31 unilateral cases the immediate result, confirmed by an x ray picture, was entirely satisfactory in 28; in two the head persisted in rising on to or above the upper lip of the acetabulum; in the remaining case the head was a trifle higher than it should have been though not really on the upper lip. If I saw such an appearance in another case I should deem it sufficient excuse for cutting down on the joint. Of the two failures one had been treated unsuccessfully by Lorenz's method two years previously, making the stretching of the muscles for the second time a matter of considerable difficulty, and the other case had been manipulated a few days previously by a colleague who failed to retain the head in the acetabulum. Of the nine bilateral cases reduction was obtained on both sides in seven, on one side only in one, and in the last a femur was broken (to this I shall refer in detail below), reduction not being attempted on the other side. Thus, out of 17 hips to which the manipulations were applied a satisfactory reduction was obtained in 15, or taking unilateral and bilateral cases together with 48 hips immediate reduction was obtained in 43—i.e., in just under 90 per cent. The details of the operation are as follows. The child is anæsthetised and the skin in the region of the hips is thoroughly washed up with ether soap and dried with a sterilised towel. It is best not to have a compress applied beforehand as it softens the skin and makes it more liable to injury by the hands. Boric powder is freely applied throughout the operation. A pad of sterilised absorbent wool is placed over the side of the pelvis opposite to the one to be operated upon and over this and the upper part of the thigh the assistant places his hands with which he holds the pelvis to the table. The adductors are first stretched and broken by forcible abduction of the thigh which has been flexed to a right angle, while vigorous massage is applied to these muscles close to their origin from the pelvis. It is important that the two hands should be used to the best advantage so that the muscles may be torn with the least amount of exertion and the smallest amount of chafing of the skin. Instead of using the ulnar border of the hand to knead and hack the muscles I prefer to use the thumb, which should be covered with a layer or two of sterilised gauze and placed as near the pelvis as possible, so that the muscles are torn away from their attachments to the bone. The direct pressure of the thumb of one hand and the stretching force obtained by pressure at or above the knee with the other must be applied simultaneously, and an increase in the one should be accompanied by an increase in the other. By these means the adductors of even the older children can be broken without much difficulty. The adductor longus is more easily dealt with than the deeper muscles; the gracilis is usually stretched with the hamstrings. In all but the youngest children the flexor muscles are next stretched by over-extension of the joint, the knee being fully flexed, so that the rectus shares in the stretching. The extensors and hamstrings may be similarly stretched by flexing the hip with the knee extended, though the hamstrings are better left till the head has been reduced, as they can be at once relaxed by flexing the knee. This manoeuvre requires care, as it is during this stage of the manipulations that the sciatic or one of the popliteal nerves is particularly liable to injury. In many cases this manipulation is unnecessary. If it is still impossible to pull the trochanter down to its proper level direct traction may be made on the leg. Reduction should now be attempted by a movement exactly as if a traumatic dorsal dislocation were being dealt with. The knee is carried up over the abdomen, then outwards till the thigh is nearly at right angles with the trunk, and then is forced backwards till the head of the bone is felt to slip forwards into the acetabulum. While one hand is employed in carrying out this manipulation the other, with its thumb on the anterior superior iliac spine and its fingers on the trochanter, aids the reduction by forcing the head of the bone downwards and then forwards into the joint. If difficulty is experienced a padded wedge may be placed obliquely beneath the trochanter and the thigh levered over it. Great care is taken that the wedge does not slip below the trochanter. When the head slips forwards into place it can be felt below Poupert's ligament, and the hamstrings will be found to be short and to resist extension of the knee. The head is now either in the acetabulum or at any rate opposite it. Any folded-in portions of the capsule are now pulled out of the way and tight portions stretched by forcible rotation of the leg in

both directions while the knee is forced further and further back. This forcing back of the knee is an important detail, as if this is not done the reduced head will be less stable and the anterior muscles will not be kept on the stretch and so the lordosis, if present, may not be permanently cured. The leg below the knee must not be made too much use of to obtain this forced rotation or the lower epiphysis of the femur may be separated from the shaft. It is not uncommon to hear and feel the capsular bands giving way. The hamstrings and gracilis are now stretched by extending the knee fully; these muscles usually only stretch and are not torn. The operation is now completed and after redislocation reduction should take place easily if, with one hand supporting the foot, the thigh is flexed to a right angle and the knee allowed to drop outwards by its own weight. The stability of the reduced head is then tested by slowly bringing the leg down parallel to its fellow and by raising the knee till the thigh is in the right angle flexion position; in this way the size of the upper and posterior lips, respectively, of the acetabulum is determined. The prognosis is correspondingly better the wider the range of movement possible before dislocation occurs. A great deal has been written on the question of what is the best position in which to fix the leg in plaster-of-Paris. While it is inadvisable to adopt the same plan for all cases it may be said that the best position for the majority of cases is one in which the thigh is at a right angle with the trunk and the long axis of the femur is directed outwards and distinctly backwards, so that in a bilateral case the child in the supine position would be resting on the outer sides of the knees, and have the sacrum off the table. This position is, I believe, the one in which it is said that the femur is neither rotated out nor in, though it is obvious that a similar position would be obtained if the thigh were abducted to a right angle and then rotated out through 90°. Lorenz applies the plaster over a pair of knitted drawers and a thick layer of cotton-wool, and forms a comparatively narrow though stout band of plaster around the opposite side of the pelvis. There seems to be a great tendency for the plaster as it gets loose to ride up and down over the opposite iliac crest as the child walks, and for the femur to have an undue range of movement in the direction of adduction. I prefer to place a small piece of wool over each anterior spine and then apply a flannel bandage, and over this the plaster, in the form of plaster bandages and long strips of house-flannel soaked in plaster cream, making the pelvic band as wide as possible. The general custom is to carry the plaster case as high up the inner side of the thigh as possible and to cover the whole of the front of the joint. This seems to me unnecessary and even disadvantageous, as the femur can be efficiently fixed in the required position without doing either. The pressure of the plaster around the joint is of no use; the stability of the joint depends upon the direction of the long axis of the femur. If the edge of the plaster case passes round just above and outside the place where the head of the femur is to be felt, the position of the bones can be examined with ease from time to time, and, more important still, when a skiagraph is taken a day or two after the operation the rays passing through the greater part of the joint have no plaster to traverse, except perhaps a thin layer behind (Fig. 3). The strength of the cast can be insured by thickening it on the outer side. The cast should end just above the knee to allow this joint to be extended regularly and the hamstrings prevented from re-contracting. The pain after the operation is considerable as a rule and morphia is generally required for the first 24 hours, after which the pain rapidly subsides, so that after 48 hours or so the child is fit to be moved to the x ray room. If the operation has been successful the head of the femur should be opposite, or, better still, a trifle below the level of, the Y-shaped acetabular cartilage which can always be made out, and the axis of the neck and head of the bone should be directed towards this spot. There often appears to be an undue amount of separation between the ossific centre of the head and the acetabular bone; particularly is this the case with young children. If the femur is low enough this separation need not give rise to anxiety, as it is explained by the fact that in the younger children the acetabular cartilage is thicker than at a later age, while the head of the femur is largely cartilaginous. In older children the bones should appear to be in better position.

It is quite a common occurrence to find that the knee and lower part of the leg at the end of the operation, both before and after the application of the plaster, are somewhat dusky

in appearance and that the circulation in these parts is sluggish. This is due to the stretching, and therefore narrowing, of the vessels, particularly the vein, over the replaced head of the femur, and usually passes off in the course of an hour or so. Although I have met with it repeatedly, and always have the leg examined from time to time during the first few hours, I have never had to remove the plaster to relieve it. The slight cracks which commonly appear in the stretched and bruised skin over the adductors should be dusted frequently with boric powder.

The dangers of this operation must never be forgotten, but with care they should be avoided. They are fracture of the femur or pelvis and injury to the peroneal, anterior crural, and sciatic nerves. Lorenz in 1905 published the following accidents in 450 cases: fracture of the femur, 11 cases; fracture of the pelvis, 3; peroneal paralysis, 3; crural paralysis, 5; sciatic paralysis, 3; rupture of the femoral artery, 1 case; and gangrene, 1 case. He also had some deaths from the anæsthetic. Narath described a hernial bulge beneath Poupart's ligament but other surgeons do not appear to have been troubled by this complication. I have to confess to two calamities in my series of 48 operations. The first case is the one alluded to above in which I broke the femur. This was a bilateral case, in a girl, aged 5 years, the femur breaking just below the trochanters after a prolonged and tiring attempt to reduce one of the dislocations. I wish to draw particular attention to this case as I believe that it was due to my being tired and careless after a too prolonged battle, and allowing the wedge to slip down below the great trochanter. The femur naturally broke across this fulcrum; it was an accident which should have been easily avoided. The femur united in good position and the child is apparently no worse off than she was before the operation. The other accident was suppuration of the hæmatoma resulting from laceration of the muscles in front and to the inner side of the joint. The case was that of a boy, aged three and a half years, with a unilateral dislocation which had been operated upon by the Lorenz method two years previously. As a result of this first operation the second was extremely difficult; there was a dense fibrous band in the region of the pectineus which gave a great deal of trouble before it would give way. The head of the femur would not remain in or opposite the acetabulum and I decided to do an open operation three weeks later. Unfortunately a rapidly spreading abscess developed in the lacerated muscles of the leg, and in spite of numerous and free incisions the suppuration could not be checked and the child died. The damage done to the skin over the adductors was not excessive, and the cracks which appeared healed rapidly. The child did not seem to possess the slightest power of resistance, and nothing we could do seemed to help him. I take it as a warning to be careful not to operate on a child who does not seem fit to withstand the operation, particularly when there is any reason to anticipate unusual difficulty with the reduction. Some swelling and œdema, without any suppuration, may persist in the adductor region for several weeks; I have seen it last six months over the replaced head of the femur and disappear after the plaster was removed and the leg allowed to come down.

Time will only allow me to refer briefly to the after-treatment, though this is so important that it cannot be passed over. The essential point is that the plaster should be retained for a sufficient length of time. This should be at least six months and should often be nine or more. The cast is changed if it becomes soiled, broken, or too loose. After six months or more the leg may be brought down a little and the plaster reapplied for another month, after which the position may be improved and the leg again fixed in plaster for a month, after which the child may be allowed to go free. Except for the first day or two after the operation the hamstrings must be stretched by extension of the knee, which after a few days of partial extension must be carried out to the full extent and repeated two or three times a day till the plaster has been removed and the leg has nearly regained its normal position. The child should also be made to carry out this movement unaided. If the plaster is kept on long enough and the hamstrings are not allowed to contract, I doubt whether the other details of the after-treatment, such as massage and exercises, have much influence on the ultimate result so far as the joint itself is concerned. That the child be allowed and encouraged to walk in the plaster does not appear to me to be essential,

though it is undoubtedly advisable, if only for the sake of the child's general health and the nutrition of the limb. My first cases were not allowed to walk while the leg was in plaster, yet of the first four, the operations upon which were performed between three and a half and five years ago, three show anatomical cures and one subspinosus reposition with an excellent functional result. In this last case the head of the femur is firmly planted beneath the anterior inferior iliac spine.

I have here skiagrams showing the present condition of the hip-joints in the three successful cases. (Figs. 4, 5, and 6.) Although these children were kept off their feet while in plaster, in two there is no shortening of the limb on the affected side and the feet are equal in size. The third case unfortunately developed a paralytic condition of the other leg, so that the previously dislocated limb is now the better and the longer of the two, though 18 months after the operation the legs were equal in length.

We now pass to what you probably consider the most interesting part of the subject—namely, the ultimate results obtained in these cases. It is advisable to warn the parents of a case of congenital dislocation of the hip that the leg may take several months to come down to its normal position and that the walk is not likely to be good till some time after this has occurred. In the younger cases a couple of months may see the leg properly down and capable of being rotated in but in the older cases it may be two years before the leg can be adducted and rotated to the normal extent. Delay in the descent of the leg is by no means a bad sign, as the longer the time occupied in bringing the leg down the less likely is redislocation to occur. The thigh on the affected side remains thinner than that on the other for some time and the asymmetry of the adductor region is obvious for many months. As to the joint itself the condition can only be accurately determined by the use of the x rays. The head of the femur is often unduly large and may extend outwards farther than it should, giving the impression that it is not really in contact with the acetabulum, while the x rays show that redislocation has not occurred.

Lorenz in 1905 published 365 unilateral cases with 60 per cent. anatomical cures, and 34.7 per cent. "subspinosus repositions" with good functional results. In 158 bilateral cases—i.e., with 316 joints—he gives 60 per cent. anatomical cures and 20 per cent. subspinosus repositions. Hoffa gives a lower percentage of anatomical cures and a higher percentage of good functional results, and he says that a satisfactory result should be obtained in 80 per cent. of all cases treated by the open or the bloodless method. Excellent results have also been obtained in this country by Jackson Clarke, W. E. Bennett, and others. In many of my own cases sufficient time has not elapsed to allow conclusions to be drawn as to the ultimate result, several being still in plaster. In 17 unilateral cases in which the leg has come down parallel to the other the x rays show that an anatomical cure has resulted in 14; subspinosus reposition has occurred in one; in the remaining two the head of the femur is a little high and a little far out, though still below the upper lip of the acetabulum; in these the head will probably settle into the subspinosus position. In these three cases the functional result is good. Owing to the slow descent of the legs in the bilateral cases in only two cases does it seem fair to judge at present of the result. In one of these the immediate result of the operation was a failure on one side and on the other side a relapse has occurred. In the other case an anatomical cure was obtained on both sides. Unfortunately the result in a few cases in which an anatomical reduction has been obtained has been somewhat marred by shortness of the leg. This shortening is due to imperfect development of the head and neck of the femur and, in fact, of all the bones of the leg, including the foot. A cork sole of appropriate thickness in the boot of the affected leg will enable a perfect functional result to be obtained. Shortness of the leg was noted in four of my cases in which the x rays showed the hip-joint to be reduced. The ages of these cases varied from two to nine years and the amount of shortening from three-eighths to half an inch. It is possible, even probable, that this want of development of the bones of the affected limb is increased by the fixation in the plaster cast, and therefore the occasional occurrence of this shortening must be looked upon as an argument in favour of making the patients walk while in plaster. Yet the use of the limb while in plaster, as already stated, is not essential, for my first three successful cases present no shortening and not one of them walked during the

first six months of treatment. The deformity is certainly not entirely due to disuse, for it may be seen in cases in which no treatment has been attempted. I have noted a difference of half an inch between the distances from the tip of the trochanter to the tip of the external malleolus on the two sides and I have seen the foot of the dislocated limb distinctly smaller than the other, in both instances before treatment was commenced. In rare cases the joint remains rather stiff for a long period, apparently the result of a mild arthritis. It must be admitted, therefore, that every anatomical cure is not necessarily accompanied by a perfect functional result, though it is in the majority of cases. Even when the function of the leg cannot be called perfect it is always much improved by the reduction, and as the child grows up the disability will tend to decrease and probably disappear, whereas if left untreated the leg is an increasing source of trouble.

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THE SUPPORTS-IN-CHIEF OF THE FEMALE PELVIC VISCERA.¹

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It has been supposed that the supports of the pelvic viscera could be discovered by anatomical research, but it is a significant fact that, in spite of much anatomical activity in this direction, the answer to this important question is not yet established. The non-arrival at a satisfactory conclusion is, it seems to me, the result of the endeavour to elicit the functions of structures by anatomical dissections alone rather than by conjointly investigating the actual living processes which occur in the body with the structure of the parts concerned. Moreover, it is strange to find that the results of experiments made on the dead are frequently accepted as showing what occurs in the living. Thus a corpse may be suspended and the whole pelvic floor removed and yet the uterus may remain very much in place. This shows what may happen in the dead when the pelvic floor is removed, but as regards the living it shows nothing at all. A thick piece of tendon may be removed and a weight suspended from it for a considerable time and very little stretching occurs; in the living marked stretching occurs. A dead femur may be taken and so arranged that considerable and long-continued pressure be brought to bear upon it between its lower extremity and its head, but the angle of the neck does not yield. A heavy body may be made to press on a dead sternum with no effect but in the living sternum marked curvature or perforation soon occurs. Thus, the futility of anatomical research alone is shown and the necessity of turning to the living body and of investigating the actual living processes occurring therein is made evident. Yet the physiology of the pelvic floor musculature and of its attachments has been sadly neglected, nor have the living processes which determine the statics of the pelvic viscera been recognised.

Anatomical dissection shows that the pelvic cavity is shut in below by the levator ani muscle, the coccygei muscles, and their connective tissue attachments. This muscular sheet, variously styled the pelvic diaphragm or the pelvic

floor, limits the abdomino-pelvic cavity inferiorly; and in uniformity with the other limiting musculature of the body cavity it is clothed, as Derry has ably pointed out, by a layer of subperitoneal tissue, and it is lined by peritoneum. Within this subperitoneal tissue and imbedded in it the pelvic viscera lie; and these, protruding into the coelomic cavity, elevate the peritoneum from off the pelvic floor. Besides viscera this layer contains the blood and the lymph vessels, the lymphatic glands and the nerves, and the ureters. In places it is composed of soft loose cellular tissue containing more or less fat according to the condition of the subject; in other parts the tissue has become condensed to form ligamentous strands in which unstriated muscle is found, especially in relation with the pelvic blood-vessels and which therefore have been styled the perivascular connective tissue sheaths. Owing to their strength and to the fact that they are attached to the bone it has been supposed they constitute the chief and the only supports of the viscera. In this modification of the subperitoneal tissue nothing remarkable exists, for a similar condition is found elsewhere in the body—e.g., in connexion with the duodenum. Where this latter becomes continuous with the jejunum an abrupt bend—the duodeno-jejunal flexure—is formed which is “fixed by a thin band of unstriated muscle attached above to the strong connective tissue around the coeliac axis as well as to the left crus of the diaphragm and which below joins the muscular coat of the duodenum at the flexure.” This band is known as the suspensory muscle of the duodenum.² Those who believe that the perivascular connective tissue sheaths alone support the uterus and the other viscera may also believe that this muscle of the duodenum is a veritable supporter of the flexure referred to and that without it the gut would sink to the pelvis. In spite of all that has been said to the contrary, my opinion is that this muscular band does not support the duodeno-jejunal flexure in the sense that a wire may be said to support a picture which hangs suspended by it on the wall; but I believe that the duodenum rests upon the viscera below it which are themselves kept in place by the intra-abdominal pressure, that is, by the tonic contraction of all the muscles which surround and inclose the abdomino-pelvic cavity.

During life the duodenum is continually undergoing peristalsis, vermicular movements which necessarily exert tension on that part of the gut that is most fixed, and this tension is transmitted to the subperitoneal tissue in which the gut is imbedded. The frequent and moderate strains to which this tissue is thus exposed have resulted in a modification of structure to meet these strains and thus this muscular ligament has been developed, just like the cancellous tissue in the upper extremity of the femur has developed in that way the best suited to oppose stresses, primarily because the stresses had to be met. I therefore see in this thickening of the subperitoneal tissue nothing other than a mechanism which acts by anchoring the viscus and thus prevents a too great excursion of it, just as a rope fixed to a bank may prevent a boat drifting down stream but cannot be said to support the boat. The whole duodenum, then, is supported by the adaptation of all the other viscera around it, which are themselves kept in place by the tonic contraction of the inclosing muscles. Within the local duodenal area movements are continually in process and the tissue in question moors the viscus to the spine. When the abdominal wall becomes inefficient then the test of support arises and the suspensory muscle of the duodenum, like the perivascular connective tissue sheaths of the uterus, is found to be a support merely in name and utterly useless for the living purpose that the anatomist considered the dead tissue capable of.

There is no essential difference between the condensation of the subperitoneal tissue in one place and that in another; and with identity of structure we may, I think, fairly argue identity of function. When, however, we glance at the visceral connective tissue strands which radiate from the circumference of the pelvic wall to the cervix it, indeed, looks as though these strands might support the uterus. But when we compare this apparatus with the pelvic diaphragm lying beneath we find the essential difference between these two structures is, that whilst the pelvic diaphragm on account of its striated muscle, is a highly elastic obturator, the pelvic visceral connective tissue is little if at all elastic. It is this lack of elasticity, the impossibility of yielding to excessive pressure from above without stretching, and the

¹ A paper read before the Obstetrical and Gynaecological Section of the Royal Society of Medicine on May 14th, 1908.

² Cunningham: Anatomy, 1906, p. 1070.