The Pelvic Floor Aperture :

WITH AN APPENDIX.

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The Pelvic Floor Aperture.

On a former occasion I brought forward evidence to show that, whatever the position of the individual or the movement momentarily in progress, the pelvic floor musculature is the essential element concerned in the support of the pelvic viscera.[20] It were easy to understand that the pelvic floor could efficiently perform this task were it an exactly fitting and complete obturator; since, however, a deficiency, small but still of no mean proportions, exists in its structure, the problem to be solved is : How is retention of that part of the visceral mass which abuts upon the deficiency, that is, the lower part of the anterior vaginal wall and base of bladder, effected?

The deficiency in the pelvic floor may be spoken of as its "aperture." It is placed in the median line and in the anterior part of the floor. It is somewhat triangular or longitudinally oval in shape (Halban and Tandler[8]). Its base is in front, and is formed by the median aspect of the pubic arch and subpubic ligament; whilst the sides, which converge posteriorly, are formed by the median borders of the bilateral levator ani muscles. With the woman standing erect, the aperture is placed in the horizontal plane, or it slopes slightly upwards from before backwards,* a condition which depends upon the inclination of the pelvis. Halban and Tandler have called this aperture the " Levatorspalt," *i.e.*, the cleft in the levator.

The individual parts of the two levator ani muscles partaking in the formation of the boundaries of the pelvic floor aperture are of especial importance, and, according as we view the aperture from above (intra-pelvic), or from below (extra-pelvic), essential differences will be found. The most median and anterior part of the levator ani muscle consists of two laminæ, one placed above the other, both of which arise from the region of the pubes, lateral to the symphysis.†

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* "*i.e.*, approximately, from the inferior margin of the symphysis backwards to below the perineal curvature of the rectum." (Halban and Tandler, *ibid*).

† Prof. P. Thompson says : " From the symphysis " (31, p. 80).

The superior lamina (pubo-coccygeus) of each side passes backwards and inwards; and each unites with the other behind the rectum, to be inserted, either by a forked aponeurosis into the last sacral vertebra (P. Thomson [31]), or simply into the ano-coccygeal ligament (Piersol [24]), towards which they converge. They are thus slung in a strap-like or hammock fashion, between the pubes in front and the sacrum or coccyx behind; thus, when their tonic contraction is augmented, they will offer an increased resistance upwards, preventing a descent, or indeed causing an elevation of the viscera. They are indeed admirably adapted for the support of the superimposed structures (P. Thomson [31]). Such increased contraction, on the other hand, will have little effect on the antero-posterior diameter of the pelvic floor aperture, the upper part of which they limit. It can only do this by raising the pelvic floor and thus causing, indirectly, such diminution; but since the excursion of the pelvic floor in health is by no means great (Herman [11]) such alterations will be correspondingly small. If, on account of such activity, an increased contraction result in a shortening of the muscle on each side—by no means an invariable concomitant—the transverse diameter of the aperture may be lessened by the bulging inwards of the muscle belly which results from such shortening (Hildebrandt [14]). Such bulging, however, occurs in all directions, and such diminution of the aperture transversely must be small and insignificant. In the lower animals, however, *e.g.*, in the dog, the increased contraction of the pubo-coccygei, which are disposed similarly to those in man, cause a closure of the slit which they limit, and through which the rectum and uro-genital passages pass; for their insertion into the tail is fixed by the extensors of that organ, and since the fibres bordering the slit are attached medianly below (pubic symphysis), and also medianly above (ventral mid-line of tail), their contraction will cause them to approach the median line—their fibres, instead of running circuitously around the rectum and vagina, will tend to run less circuitously—and this happening simultaneously on each side, will cause a bilateral compression of the rectum (and vagina), and indeed its occlusion. And Mr. Harrison Cripps [5] is of the opinion that a similar bilateral compression of the rectum occurs in man. He says (*ibid*): " . . . . it will become obvious what must be the action of the levatores ani when they both contract simultaneously. So far as the coccyx is movable, they will tend to draw that bone upwards towards the symphysis, but, since in most bodies the coccyx scarcely moves, they will act powerfully as compressors of the rectum, squeezing the sides of the canal together as it passes between their two inner surfaces. In fact, when contracted, owing to their insertion near the middle line, they assume a shape like the letter V, the arms of which only diverge about one inch from each other at their attachments to the symphysis." Since, however, the attach-

ment to the pubic bones in man is usually not median, and, moreover, since there is no muscular mechanism in him capable of causing extension and thus rigidity of the coccyx—the extensors, when present, being very rudimentary—it seems this bilateral compression certainly cannot occur to anything like the same extent as in the lower animals; and although, when the coccyx is fixed by an increased visceral down-thrust, the bilateral contraction of the pubo-coccygei may possibly effect some such lateral compression of the rectum and vagina, this does not seem to be sufficient to efficiently guard the aperture and prevent escape of the viscera.

Very different, however, are the attachments of the other lamina of the muscle (pubo-rectalis), which is situated in a plane inferior to that of the pubo-coccygei we have just considered. This also arises from the pubes, passes backwards on each side, lateral to the vagina, and sweeping around the rectum, unites with its fellow of the opposite side immediately behind the gut.* This muscle, because it arises from the pubic bones and encircles the rectum, is called the pubo-rectalis. Of utmost significance is the anatomical fact that it is neither connected with the vertebral column by means of an aponeurosis nor to the ano-coccygeal ligament; even the union of the muscle of one side with that of the other behind the rectum, according to Luschka,[18] Henle,[9] Schatz,[27] and others, and which my own dissections confirm, unlike the rest of the pelvic floor musculature, is effected without the intervention of fibrous tissue, the fibres of the muscle of one side being directly continuous with those of the other. Thus the fibres arising from the pubis of one side, passing around the rectum posteriorly and returning to the pubis of the other side, may be considered as a single entity.

This freedom from the vertebral column allows the advance, provided the contents of the aperture permit it, of the posterior commissure of this muscle (*i.e.*, the part of the muscle passing from one side to the other behind the rectum) towards the symphysis when the muscle contracts; the muscle is, therefore, capable of causing considerable pressure to bear upon the structures placed between its posterior commissure and the symphysis, *i.e.*, upon the contents of the pelvic floor aperture, thus causing their occlusion and preventing an escape of whatever may be within the pelvis (*e.g.*, pessary) to without. If a diminution of these contents can occur, and a shortening of the muscle takes place, a lateral bulging of the muscle is also produced, and the transverse diameter of the pelvic floor

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* Some of the anterior fibres of the pubo-rectalis pass to the side wall of the rectum (anal canal), insinuating themselves between the internal and external sphincters, whilst others join the longitudinal musculature of the gut (Kalischer). These, compared with the main mass of the pubo-rectalis, are relatively insignificant, and in the specimen I dissected, like the insignificant pre-rectal fibres, resembled connective-tissue rather than striated muscle.

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aperture is encroached upon; but this can usually be but slight, and the principal effect of an increased contraction will be a diminution of the aperture in the antero-posterior diameter.

Pelvic Floor Aperture : Pirogoff's Plates.

These anatomical peculiarities of the pubo-coccygei and pubo-rectalis are very well shown by two drawings in Pirogoff's Atlas,[26] and are diagramatically represented in the figures appended. These drawings were taken from transverse horizontal sections of the pelvis. The first section passed through the ischial tuberosities and ascending rami forming parts of the pubic arch, and below the symphysis. The drawing of this section (Fig. 1) shows the horizontally disposed fibres of the pubo-rectalis passing continuously from the pubis of each side, backwards by the sides of the urethra, vagina and rectum, around the gut, without the intervention of connective-tissue or any attachment to the vertebral column. The fibres of origin are not shown, for they are attached to the pubic bones, which are above the section. This is to be explained by a presumable descent of the pelvic floor, which is common after death (Schultze[23]). It is to be noticed that the muscle has all the appearances of firmly embracing the tissues, forming the several passages, which pass through the aperture and form its contents, even although the muscle is relaxed, as it always is after death.

The next figure (Fig. 2) represents the drawing of the parts disclosed in a section through the pelvis, parallel with the former, but on a higher level. The section passed through the pubic bones and the symphysis, and through the upper parts of the ischial tuberosities. The obturator internus muscles are seen arising from the obturator membrane and the lateral pelvic walls; and medianly, separated from these muscles by the ischio-rectal fossæ, the pelvic floor aperture is displayed; still surrounded by the pubo-rectalis muscle, but also by fibres belonging to the pubo-coccygei, which pass backwards and upwards in the median line to be inserted into the vertebral column. The actual insertion is, of course, not shown, since the section has passed through the pelvis below the level of the coccyx.

Pirogoff, however, interpreted the muscle seen in the first section in a different way. He stated that the V- or U-shaped muscular sling consists of " circular fibres partly belonging to the external sphincter muscle of the anus, and partly indeed to the constrictor muscle of the vagina." Dr. Berry Hart, who has reproduced this drawing in his " Atlas of Pelvic Female Anatomy,"[2] accepted this interpretation and explained the muscle in the same way. Scrutiny of the drawing shows, however, that this explanation cannot be accepted. It is well known that the fibres taking part in the external sphincter ani muscle, as they course forwards on each side of the
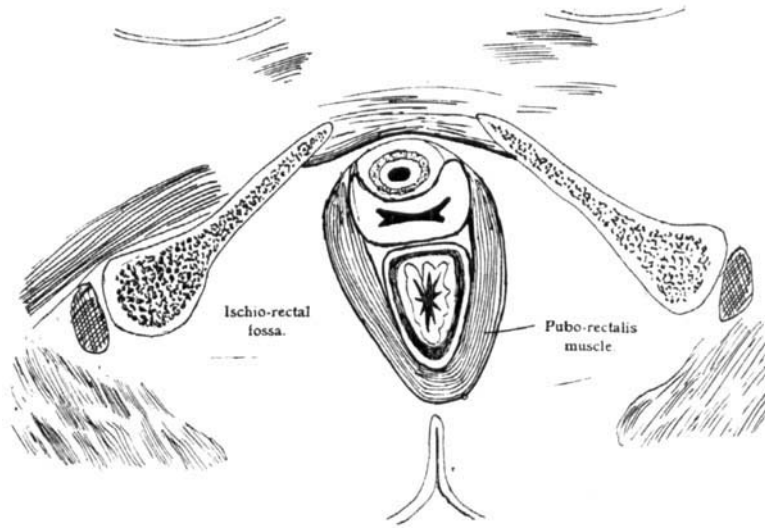
Fig. I.

From Pirogoff's "Atlas." Fasc. III. Tab. 28. Fig. 2.
(Reduced by ½.)
Shows the Pubo-rectalis muscle embracing the rectum, vagina, and
urethra. See text.

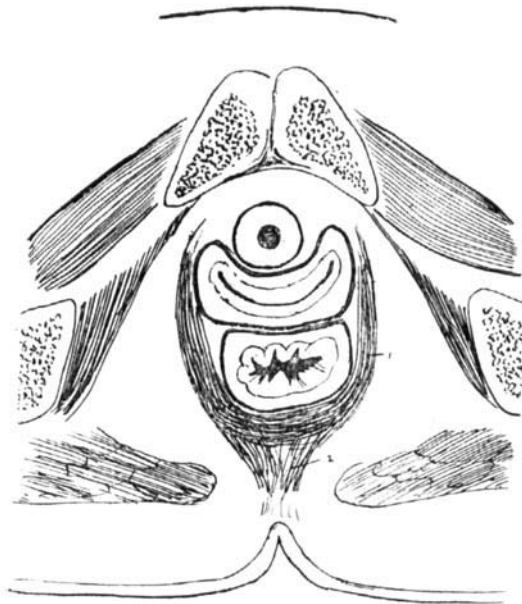

Fig. II.

From Pirogoff's "Atlas." Fasc. III. Tab. 28. Fig. 3.
(Reduced by ½.)
1. Pubo-rectalis. 2. Pubo-coccygeus. See text.

anus from behind, pass inwards from each side immediately in front
of the gut and behind the vagina, uniting in the median line with
each other to form a complete ring encircling the anus, whilst others
pass on laterally to the pubic arch (ischium) as the superficial
transverse perineal muscle of the other side (Kalischer,[17]
Thompson,[31] pp. 12 and 22). The two muscles, which together form
the so-called " sphincter vaginæ," as is also well known, arise in the
tissue in the middle line between the rectum and vagina (Kalischer,[17]
Thompson,[31] p. 37), and pass forwards on each side of its extra-
pelvic part to gain attachment to the crura of the clitoris (Mm. bulbo-
cavernosi). The external sphincter of the anus, and this so-called
sphincter of the vagina, the one placed behind the other in the
superficial parts, together form a figure of eight.

In the section as represented, it is evident the plane of division
has passed above these superficial structures, for the rectum and
vagina are in close apposition—the section has not passed through
the perineal body, but above it; it is evident, whatever this muscular
band may be, which with the pubic arch so completely encircles the
vagina and rectum, that the perineal body is below it. That this
muscle is part of the levator ani, there can, I think, be no doubt;
indeed, Pirogoff stated that the similarly placed fibres seen in the
drawing representing the other section passing through the pelvis at
a higher level—some of which have a similar circumferential course,
whilst others decussate with each other behind the rectum and pass
backwards towards the coccyx—are part of the levator ani. If this
interpretation of these two drawings is correct—and that it is so is
confirmed by palpation in the living—they demonstrate that the
pubo-rectalis muscle is not only fairly thick, but that the muscle
presents a considerable surface to the long axis of the gut, a relation
which Halban and Tandler also point out. Moreover, if this muscle
plays the part of a sphincter to the pelvic floor aperture, and thus
prevents extrusion of any part abutting upon it within the pelvis—
that is, if the tonic contraction of the muscle against the unyielding
pubic arch causes retention of the viscera (and their contents)—it is
plain that the perineal body, which is situated below the muscle, and
is, therefore, outside the influence of the intra-abdomino-pelvic pres-
sure, is out of the running in the question of the visceral support;
and it further renders intelligible the fact that fibres passing between
the muscle arm of one side to that of the other in the perineal body
(*i.e.*, the pre-rectal fibres of the pubo-rectalis), and which, it has
been supposed, act as a tie between the muscle arm of one side with
that of the other side, preventing these from falling away from each
other towards the side walls of the pelvis, and thus being rendered
functionless (Hey Groves [12])—the presence of which, however,
palpation fails to reveal, and which are so difficult to find on

dissection, and which Studdiford*[30] recently was unable to discover—are unnecessary. The pubo-rectalis muscle is, it is plain, of essential importance in the structure of the pelvic floor aperture, limiting it laterally and behind. That it plays the part of a sphincter, closing the aperture in the floor, and preventing the visceral escape, is shown by the effect its constriction has had upon the canals which pass through the aperture.

The Contents of the Pelvic Floor Aperture.

The rectum, vagina and urethra, in their transit from within the pelvic cavity to without, pass through the aperture and comprise the normal contents. Below or beyond this aperture the rectum and vagina diverge; whilst the gut suddenly changes its direction, to pass downwards and backwards as the anal canal, almost at a right angle to its former course; the vagina continues onwards almost in the same straight line, deviating but a little downwards. Usually these passages are occluded, their closure at the level of the pelvic floor aperture being effected by the tonic contraction of the pubo-rectalis. Below the level of the pelvic floor aperture the rectum and vagina, which are here separated by the perineal body, are also occluded; this is effected by the superficial sphincters, the external sphincter of the anus, being attached to the coccyx, anchoring the anus posteriorily.

At their exit from the pelvic cavity the arrangement of the rectum and vagina is somewhat peculiar, for their walls are attached, not only to each other, but also to the muscular boundary (Henle[9]). Thus, posteriorly and at each side, the smooth longitudinal fibres of the musculature of the gut intermingle with the horizontally disposed (striated) fibres of the pubo-rectalis; and the relationship between them is, therefore, very intimate. Anteriorly, a similar interweaving occurs, the anterior wall of the anal canal being more or less incorporated with the tissues of the perineal body (Kalischer[17] and others); and, moreover, a band of smooth muscle fibres passes downwards and forwards from the anterior rectal wall to the posterior vaginal wall--forming the recto-vaginal muscle (or band) of Kalischer. The importance of such a connection between the gut and the pelvic floor, during the act of defæcation, is obvious; for, whilst the increased visceral thrust causes the pelvic floor to descend, the attachment of the lower end of the rectum to this fixes the gut

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*This author says : " So far as I have been able to determine no fibres from the levator ani muscles themselves pass between the vagina and rectum, as most anatomists state." He continues : " It is my opinion that these involuntary fibres (the ones he describes), found in the perineal body, are a most essential part of the pelvic floor, etc." As regards the function or the physiological importance of non-striated fibres, in this question, the reader is referred to Halban and Tandler's splendid book, p. 27.

Fig. III.

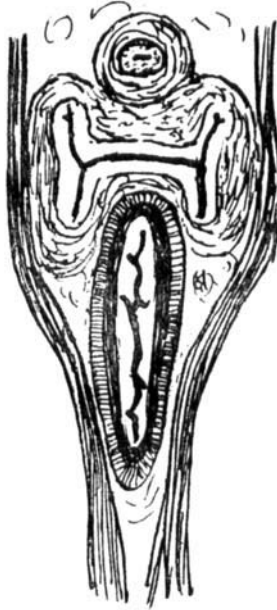Fig. III.   A reproduction of Fig. 353 of Henle's "Anatomie" (1873), page 462.   The drawing shows the H-shaped lumen of the vagina at the level of the pelvic floor aperture.   The muscle fibres seen on each side of the visceral canals belong to the pubo-coccygei. The sinuous course of the muscle fibres is a post-mortem change. The pubo-rectalis is not represented; it is placed in a plane below the level of the section.

inferiorly, so that the fæcal mass can be forced onwards by the peristalsis of the upper part.

The lateral walls of the vagina are also firmly adherent to the lateral boundaries of the aperture, and, according to Henle,[9] a similar interweaving of the non-striated muscle fibres (mostly longitudinal) of the vaginal wall with the horizontally disposed striated fibres of the pubo-rectalis occurs; in no case, however, does a fibre of this muscle end upon or in the tissues of the vaginal wall (Henle, and Kalischer; compare footnote, p. 97). Thus, the parturient canal, inferiorly, is anchored to the pelvic floor; and this attachment is of similar importance during parturition as the similar fixation of the rectum is during defæcation. That this adhesion of the lateral vaginal wall to the pubo-rectalis is very intimate can be easily demonstrated by endeavouring to pick the wall from off the muscle during any vaginal operation. Of its anterior and posterior walls at this level, the urethra is closely bound to the former, whilst the latter is similarly adherent to the tissues of the rectum and at a lower level with those of the perineal body (Henle).

In consequence of the tonic contraction of the pubo-rectalis muscle, and the fact that the canals it embraces have of necessity at times to be considerably stretched (*e.g.*, during defæcation and parturition), their tissues are at this place considerably crumpled. The mucous membrane of the anal canal is thrown into longitudinal folds, and a similar modification of the vagina takes place, the mucous membrane being markedly rugous. Since, however, the lateral vaginal walls remain more or less fixed in place—on account of the intimate relationship of their deeper structures (fibro-muscular layer) with the pubo-rectalis, which, by its splint-like activity, maintains their positions—it, of necessity, follows, as a direct result of the tonicity of this muscle and the constricting force which it exerts, that the anterior and posterior vaginal walls at the same level, which have no such direct connection, are bulged bodily inwards—the anterior vaginal wall with the urethra being projected backwards, and the posterior vaginal wall forwards—until their surfaces come into apposition, forming the conspicuous folds which are known as the "columns of the vagina." Since the anterior vaginal wall and the urethra at the level of the aperture abut upon the unyielding pubic arch, whilst the posterior vaginal wall is supported by the elastic muscle, the rectum being interposed, the greater prominence of the anterior column of the vagina is accounted for. Thus the H-shaped appearance of the lumen of the vagina on transverse section at this level, so well depicted by Henle (Fig. 3), is explained. These columns extend a little above and a little below the level of the aperture in the pelvic floor, which is situated about half an inch (Dickinson[6]) above the vaginal orifice (hymen). Above the level of the aperture, where

the intra-pelvic part of the vagina, therefore, has no such lateral muscular fixation, its anterior and posterior walls are maintained in apposition by the internal visceral pressure, and on transverse section its cavity presents as a transverse linear slit. Below the level of the aperture the columns of the vagina also tend to disappear. Here the vagina is surrounded and embraced by the bulbo-cavernosus muscles (together forming the so-called sphincter vaginæ), which gather its tissues together somewhat in the manner that a purse-string suture would do; since, however, these muscles are attached to the crura of the clitoris in front, and to the perineal body behind, they cause the lateral walls at the orifice (position of hymen) to come into apposition, and thus on inspection this is seen as a longitudinal slit, which, however, in the virgin, is of no great length. Finally, when the pelvic floor aperture has become permanently enlarged, *e.g.*, by childbirth or other causes, the columns of the vagina are found to be much less conspicuous or to have entirely disappeared.

The Uro-Genital Diaphragm.

The rectum, vagina and urethra, although they pass from the pelvic cavity through a single aperture (the pelvic floor aperture), are so adherent to each other and the encircling musculature as to be fixed in position, and to form an efficient closure on all sides to the visceral mass. Below this level the urethra and vagina pass through the superficial sphincteric muscles. These, collectively, form a triangular tendinous muscular layer, let into the pubic arch, in a plane immediately below the pubo-rectalis muscle, *i.e.*, below the pelvic floor aperture, reaching backwards as far as the anterior limit of the anal canal; it has been called the uro-genital diaphragm (Halban and Tandler). The uro-genital sphincter (see Kalischer), in its distal part, where it surrounds both vagina and urethra, forms part of this diaphragm, but only a few of its superficial fibres are attached to the pubic arch (Kalischer); as its deeper portion is traced upwards its fibres gradually recede from the vagina, and embrace the urethra alone (compressor urethræ), and this, according to Kalischer, has no connection with the bone. If this uro-genital sphincter be disregarded, the uro-genital diaphragm contains but scanty muscle fibres (Halban and Tandler).

At first sight, it would appear that the compressor urethræ muscle, in virtue of those of its fibres which do pass from side to side of the pubic arch in front of the vagina, is of some importance from the point of view of preventing an escape of part of the pelvic contents to the outside through the pelvic floor aperture; and that it, therefore, plays a part in the maintenance of the visceral support. Anatomically, however, the muscle is sometimes difficult to demonstrate (P. Thompson), and a comparison with the levator ani shows it is relatively insignificant. Clinically, one finds, whilst the pubo-

rectalis is easily and distinctly palpable as a muscular band, clearly of considerable strength, that the lower part of the anterior vaginal wall, immediately above which the compressor urethræ muscle is situated, may be easily invaginated to such an extent that the internal aspect of the pubic bones and the symphysis can be completely and satisfactorily palpated. In this examination the compressor urethræ muscle is displaced with the other tissues, and no considerable resistance—no resistance comparable to that offered by the pubo-rectalis—is presented to the finger, such as we might reasonably suppose would occur did the muscle play a part in the visceral support, for if it prevents egress, presumably it would prevent ingress. In other words, the compressor urethræ muscle, though only separated from the finger by the anterior vaginal wall, cannot be distinguished by palpation, and, therefore, cannot be placed in the same category as the levator ani muscle. In view of the structural peculiarity of the pubo-rectalis, which permits the muscle on contraction to determine a closure of the pelvic floor aperture and an occlusion and compression of the canals which pass through it, and its sufficiency for this purpose, as shown by its hypertrophy during pregnancy (Dickinson [6] and the author [21]), coupled with the unsatisfactory findings on searching for the compressor urethræ muscle by dissection, lead one to conclude that the compressor urethræ muscle in man plays no part in the support of the pelvic viscera, and to deny it as forming a part of the pelvic floor. Its function is limited to the voluntary occlusion of the urethra (Halban and Tandler), of which it is the external (voluntary) sphincter, directly permitting, controlling or checking the expulsion of urine in virtue of its contraction. It is analogous with the external sphincter of the anus, and indeed has evolved with this from the same superficial sphincteric musculature which originally surrounded the primitive cloaca. It is of significance to find that in the female these superficial muscles, derived from the primitive sphincter cloacæ, do "not attain to anything like the degree of development as in the male" (Cameron [4]). This may be due to the injury resulting from some antecedent childbirth; as an anatomical opinion, however, it is of considerable importance.

Yet Halban and Tandler hold the opinion that the uro-genital diaphragm is of importance from the point of view of visceral support, and they regard it as playing the same part to the genital hiatus* as the pelvic floor itself plays to the outlet of the pelvic cavity; that is to say, they regard it as a closing apparatus, and they advance this opinion, even although they admit it often only contains

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*The "genital hiatus" of Halban and Tandler is bounded in front by the posterior surface of the symphysis, laterally by the free borders of the pubo-rectalis, and behind by the pre-rectal fibres which meet in the perineal body, *i.e.*, in front of the rectum.

scanty muscle fibres.   They even explain the non-appearance of
prolapse in those not infrequent cases of ruptured perineum, in which
the viscera continue to be retained within the pelvis by the existence
of the uro-genital diaphragm (*ibid.*, p. 243); although, in an earlier
part of their work, they call attention to the very considerable injury
this diaphragm suffers on childbirth. Thus these authors say (p. 38):

> "Wie aus dem bisher Gesagten ersichtlich ist, bringt des
> Geburtstrauma nicht nur eine vorübergehende Erweiterung
> des Hiatus genitalis mit sich, sondern es ruft auch eine mehr
> oder minder *weitgehende, bleibende Schädigung†* im
> mechanischen Verschlussapparat des Hiatus genitalis, d.i. im
> Diaphragma urogenitale hervor."

They continue:—

> "Bemerkt sei noch, dass bei der Erweiterung des Introitus
> vaginæ vor allem die hinter der Vagina gelegenen Fasern
> geschädigt werden, da die Einlagerung der vorderen und der
> beiden seitlichen Vaginalwände in den Arcus pubicus einer
> weiteren Dehnung dieser Wände Halt gebietet " (*ibid.*, p. 38).

But this protection to the anterior and lateral parts of the uro-genital
diaphragm afforded by the pubic arch can scarcely be conceded
when we remember that, as the fœtal head appears at the vulva and
begins to protrude through it, all the tissues on all sides of the fœtal
head are reflected outwards upon its projecting part as a sort of cuff;
and whilst the perineal body is, as a rule, the part that suffers most,
this only happens because the long axis of the fœtal head in the
process of birth passes through a curved course (extension) from
behind downwards and forwards, and therefore the part of the head
placed posteriorly (*i.e.*, the part related to the fourchette) is the part
that moves most, for the arc it describes is greater than that through
which the anterior part of the head passes.   But, further, we know
quite well that the anterior vaginal wall, especially in the region of
the hymen, is often severely ruptured, although such injury is not
often looked for, as are also those parts covering the vaginal bulbs,
which then give rise to such troublesome bleeding. The reason
prolapse does not occur in cases of ruptured perineum is due to the
fact that the perineal body plays no part in the visceral support,
being below the aperture and outside the region of pressure, and
that the pubo-rectalis muscle surrounding the pelvic floor aperture
remains intact in spite of—indeed, in some or many cases because
of—the injury to the perineum; whilst the occurrence of prolapse
with an intact perineal body, when directly consequent on child-
birth, is due, as I have shown,[22] to the influence the perineal body
exercises during the act of birth, causing a continued extension of
the fœtal head, and thereby a greater distension of the pelvic floor

† [The italics are mine.—R. H. P.]

aperture than would otherwise occur, with a resulting increased stretching and greater liability to injury, *e.g.*, laceration, of the pubo-rectalis. Although Halban and Tandler lay stress on the pubo-rectalis—" auch als M. sphincter recti (Holl [16]) bezeichnet "—yet they appear to have rejected, or at least to have not sufficiently appreciated, the conception that the muscle serves the purpose of dragging the rectum (and with the rectum the vagina) forwards and against the pubic arch to such an extent as to efficiently and completely shut off the pelvic cavity and thus prevents extrusion of the viscera, for they also lay stress on the pre-rectal fibres which limit posteriorly the " genital hiatus," through which the vagina and urethra alone pass. And they do this even though they speak of " die variant entwickelten prärektalen Fasern " (*ibid.*, p. 36). Yet these authors expressly state that by the contraction of the pubo-rectalis the posterior border of the pelvic floor aperture (levatorspalt) through which the rectum, vagina and urethra all pass, is drawn towards the symphysis, and that this aperture is thereby correspond-inly diminished in its sagittal diameter, a movement by which the rectum is also drawn forwards, and is, moreover, more markedly kinked and also narrowed (Halban and Tandler); but on the same page they say that the posterior wall of the vagina at its exit through the genital hiatus is raised towards the symphysis when the levator ani contracts, " und zwar zunachst indirekt durch die gleichartige Dislokation des Rektums, ferner aber auch durch die Verkurzung der prärektalen Fasern " (*ibid.*, p. 49). To these pre-rectal fibres, and to the fact that they cannot be perceived by palpation, we have already referred. That fibres, accorded of such importance, may be divided by a laceration at childbirth—even into and through the external sphincter of the anus, so that no doubt can exist that they are rendered functionless—and that, in spite of such complete laceration, no effect should be caused as regards the visceral position (which, as is well known, is quite a common occurrence), is passing strange; for were they necessary for visceral retention, as is so often insisted, their rupture should be more frequently followed by prolapse than is the case; and that these authors should have to explain such visceral retention by falling back upon the uro-genital diaphragm, and saying that this remains intact—when contrasted with the mechanism of occlusion of the pelvic floor aperture which the pubo-rectalis so clearly effects, plus the difficulty of finding and displaying the pre-rectal fibres, or, indeed, of the other superficial muscles in this diaphragm—is, to say the least, remarkable. Does not the true explanation lie in the conception that neither the insignificant pre-rectal fibres nor the scanty muscle fibres in the uro-genital diaphragm are of any service in the visceral support?

Yet Halban and Tandler have been widely followed. Thus Piquand and Hue [25] attribute to these scanty pre-rectal fibres (releveur

pubo-vaginal) the constriction of the wax cyclinders which Budin[*][3] used in his experiments, and the results Farabeuf[7] obtained with the dynamometer. The latter observer found that such an instrument placed within the vagina indicated an increase of pressure which reached 12 to 15 kilogrammes, when " these muscles contract." It is plain that if such effects were produced by the muscle fibres passing from side to side in the perineal body, that these ought to be sufficiently numerous to form a muscular mass capable of being perceived by palpation; and much more ought they to be found easily on dissection. The actual findings disclose that the effective constrictor, to which these results were undoubtedly due, is not situated within the tissues of the perineal body, but is the main mass of the pubo-rectalis muscle, which passes behind the rectum, and which forms such a conspicuous fleshy structure that it can be so easily and plainly felt.

In support of their contention, Halban and Tandler (*ibid.*, p. 240) state that prolapse is observed very frequently after symphysiotomy and pubiotomy; for during these operations, and much more during the subsequent extraction of the child, the uro-genital diaphragm is certainly lacerated considerably as the pubic bones are thrust apart; and, further, that prolapse almost invariably follows childbirth in cases of split pelvis, because of a similar injury. Even if it be allowed that prolapse is more likely to occur after childbirth associated with these conditions, it seems more probable that the visceral extrusion is disposed to by the sometimes slight, but sometimes considerable, widening of the pelvis, which is permanent, and which almost invariably results in such cases (Whitridge Williams,[32] Munro Kerr[19]), rather than to the injury inflicted upon the uro-genital diaphragm; for this widening necessarily results in a simultaneous and a corresponding and permanent increase in width of the pelvic floor aperture, which of itself is sufficient to explain the occurrence of prolapse, and which, according to Adolph,[1] is its most frequent concomitant. And, further, it is extremely probable that the extraction of a full-term child through a pelvis so small that such an operation had been necessary to permit live delivery—a pelvis, that is, with correspondingly small muscles and a small aperture—would not only result in an immediate injury to the uro-genital diaphragm, but also subject the levator ani muscle itself (pubo-rectalis) to a more or less severe laceration.

The Closure of the Pelvic Floor Aperture.

For such reasons as these then, the uro-genital diaphragm must be rejected as being of any value in the maintenance of the pelvic viscera within the pelvic cavity. This retention is effected by the

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[*] Budin thought the same, for he says (*ibid*) : "La formation d'un veritable anneau autour du vagin serait surtout la conséquence du développement exagéré de la partie appelée par Savage muscle pubic-coccygien et au particulier des faisceaux qui se croisent entre le rectum et le vagin."

tonic contraction of the pubo-rectalis, on the one hand, and the mere mass of the structures which pass through the aperture it limits—*i.e.*, the thickness of the walls of the canals and the connective-tissue which binds them into one heterogeneous whole—on the other. The former, ever varying in response to the needs of the body, *i.e.*, the momentary prevailing pressure conditions within the abdomino-pelvic cavity, maintains a sufficient pressure—from behind forwards, and, to a lesser extent, from side to side—upon the collective mass of these structures, so as to effect their closure and prevent egress from, and ingress to, the pelvic cavity in accordance with the demands of the moment in question. This it can readily do, for it is free from connection with the vertebral column and the ano-coccygeal ligament behind; and the cells which form the contents of the pelvic floor aperture are—like all tissue cells—incompressible.

Moreover, by the position assumed by the posterior commissure of the pubo-rectalis, the pelvic floor aperture is removed from the region of impact of the visceral pressure from above, for this is transmitted through the axis of the brim and strikes the pelvic floor in the region of the coccyx—the pelvic floor aperture is not in the direct line of pressure, as has been supposed,—and the rectum has been caused to form a conspicuous perineal flexure, the vagina also being affected, as is shown by its sigmoid course.

Thus, by this compression from behind forwards against the pubic arch, an occlusion of the rectum and vagina is easily determined. Because of this action upon the gut, Holl called the pubo-rectalis the sphincter of the rectum. Its action upon the vagina is similar, for this passage at the level of the aperture is only separated from the posterior commissure of the pubo-rectalis by the gut and the intervening tissue in the recto-vaginal septum. Thus the muscle plays an important part during coitus (Hildebrandt [15]), sometimes causing retention of the penis within the vagina—penis captivus—as Hildebrandt, Budin and others have given instances; and, according to Dickinson,[6] the muscle is especially well developed in erotic women and in patients suffering from painful lesions about the vulva and anus, *e.g.*, fissures, as well as in muscular subjects, *i.e.*, in those accustomed to hard work, as young domestics, and in women with wide pelves. This sphincteric action is further shown by the pleating or crumpling of the passages at this level.

That the pubic arch plays a prominent part in this mechanism is shown by the marked indentations which were produced anteriorly in the wax cylinders Budin used to investigate this closure of the vagina. Impressed by Hildebrandt's paper, Budin [3] investigated the sphincteric action of the levator ani by inserting a cylinder of wax, 37 mm. in diameter into the vagina, the muscle being voluntarily relaxed, and then getting the patient to contract or draw up the parts as much as possible. After subsequent relaxation the cylinder was

removed.   Examination showed an impression had been formed in the wax which, whilst completely encircling the cylinder, was most marked anteriorly, corresponding to the lower border of the symphysis.   Measurement of the constricted part showed that the antero-posterior diameter, instead of 37 mm., measured only 26 mm., and the transverse diameter 35 mm.   In another patient, who was pregnant, the contraction was more powerful still, the antero-posterior diameter of the resulting constriction being found to measure 24 mm., and the transverse diameter 32 mm., instead of 37 mm. in each.

This experimental work of Budin, which has been confirmed by Dickinson, shows that on active contraction of the levator ani muscle the aperture in the pelvic floor, previously distended, may be considerably reduced, and that the reduction takes place for the most part in the antero-posterior diameter of the aperture.   This is caused by an advance of the posterior commissure of the muscle towards the symphysis, which determines a constriction and occlusion of the rectum and vagina, already referred to.   The reason why the impression, posteriorly and laterally, was less deep than in front is to be found in the fact that, whilst the muscle fibres form a fairly broad band at the sides and behind, the anterior limit of the aperture formed by the inferior margin of the pubic arch is sharp (Budin). Budin adds that it is certain a much greater constriction than that found in the cases reported would have been obtained by using a substance less resistant to the muscular contraction than the fairly firm modelling wax, and which at the same time had possessed the capacity of preserving its resulting form.   What reduction takes place when the vagina is empty we cannot tell; but we know that in vaginismus this muscle is so contracted that it is impossible to insert a finger into the passage.   It is obvious the potential closure of the aperture in the pelvic floor by the activity of the pubo-rectalis muscle is considerable; it is, indeed, so effective in the majority of women as to maintain the pelvic viscera within the pelvis.

In support of this conception the following may be adduced : —

A. As regards the *Pubo-rectalis Muscle.*

1. Its muscular development.   (See Holl.[16])

2. Its presenting a broad surface to the passages which pass through the aperture it limits (Tandler and Halban).

3. Its strength.   (See Dickinson.[6])

4. Its ability, in virtue of its striated tissue, to function continuously throughout life (see Sherrington [29] and Pembrey [23]), to react rapidly to rapidly occurring pressure changes, and to adapt itself to more slowly occurring pressure conditions (hypertrophy).

5. Its sphincteric action upon the rectum (Holl) and upon the vagina (Hildebrandt, Budin and others).

6. Its spasm in vaginismus.

B. As regards the *Passages which pass through the Aperture*.

7. The existence of the columns of the vagina depend upon the continued activity of the pubo-rectalis.

8. The existence of the perineal curvature of the gut and the sigmoid course of the vagina are similarly dependent upon the continued activity of the same muscle.

The Retention of the Viscera during Straining.

That such a mechanism surrounding the pelvic floor aperture is all important for the prevention of the escape of the viscera may be readily allowed; but that it is not the only factor is evident from the fact that during bearing down efforts a descent of the pelvic floor, with an increase in the size of its aperture, occurs; for inspection shows that a greater length of the obliquely placed anterior column of the vagina " comes down " and occupies part of the pelvic floor aperture. Since during this movement the visceral pressure is increased—for it is this increase which causes the *inhibited* pelvic floor to descend—the question arises : How is extrusion of the viscera prevented at these times? It will be allowed that such straining is of infrequent occurrence, that, although great increase of the visceral pressure may be produced frequently in the course of each day by such acts as lifting weights, coughing, etc., in which cases, however, a maximal contraction of the pelvic floor is always possible and presumably occurs, such increase as that caused by straining, in which the pelvic floor is inhibited, and, therefore, is not capable of contracting maximally, is rare, and, indeed, only happens in connection with difficult defæcation (and parturition); and, further, if such straining does occur frequently prolapse often results. But the increase in size of the pelvic floor aperture consequent on straining is presumably not unlimited, and, therefore, it is necessary to ascertain the amount of descent of the pelvic floor and the increase in size of the aperture incident to straining.

Some twenty years ago Dr. Herman [10] measured the descent of the pelvic floor produced by straining in 110 cases, and found on the average an increase of the superficies from before backwards of 3·04 cm. occurred; that is to say, just a little over an inch. I have made similar measurements to these in 27 cases (see Appendix), and, although there is a good deal of disparity between the extremes— the greatest increase being two inches, the smallest only a quarter of an inch—on the average the increase measured 0·96 of an inch. The result of such measurements depends, of course, upon the kind of patient; a few marked cases of prolapse would send up the average very considerably. There were a few cases of prolapse in my list, but in none was the prolapsed mass large, and most of these were wearing rings. Since, however, such cases are included, it would seem that normally the average increase on straining is less than

seven-eighths of an inch. As regards the actual descent of the pelvic floor in health, Dr. Herman [11] says:—" The perineum ought not to descend more than about half an inch when the patient strains."

Retention during Straining. Measurements.

It must be admitted that the measurements obtained are remarkably small, much smaller than one would think. In some cases that I have examined, the patient lying on her left side, there has appeared to be no descent at all on straining. In such it will generally be found that the abdominal contents are small in volume, and that when the patient turns on her back the abdominal walls sink in towards the spine. Thus, in these cases, when the patient is lying on her side, it will be very difficult for her to markedly raise the intra-abdomino-pelvic pressure, at least sufficiently to cause the viscera to bulge the pelvic floor downwards; and to do this effectively she must diminish the capacity of the abdomino-pelvic cavity by flexing the spine and causing the thorax to approach the pubes. This is equivalent to possessing relatively increased abdominal contents, in which condition it is easy to produce an increase of the intra-abdomino-pelvic pressure in any position. That is to say, the crouching attitude must be adopted, as, indeed, is usual when defæcation is attempted. Hence the relative capacity of the abdomino-pelvic cavity and the volume of the abdomino-pelvic contents is of considerable importance—a relation which is, as a rule, entirely overlooked in the consideration either of the maintenance of the pelvic visceral position or of the causes which determine prolapse of the same.

It is somewhat difficult to obtain exact ideas as regards the size of the pelvic floor aperture, since the tonic contraction of the pubo-rectalis muscle is always varying in response to the pressure within, and which depends, of course, upon the posture of the individual and the movement (if any) in progress. Measurements in a resting position cannot be taken as showing the actual size when the muscle is vigorously contracted, as when the individual determines to prevent ingress to, or egress from, the abdomino-pelvic cavity; nor can measurements after death, when the tone of the muscle has disappeared, be supposed to represent the actual conditions during life.

Several measurements, however, have been taken of this aperture. According to Halban and Tandler (*ibid.*, p. 36), the transverse diameter, which corresponds to the greatest distance between the two arms of origin of the pubo-rectalis muscle, and normally measures as much as the transverse diameter of the vagina where this passes through the aperture, is found to be:

In new-born children ... ... 1 cm.
In virgins ... ... $2\frac{1}{2}$ cm.
In women who have borne children ... ... 4 cm.

The longitudinal diameter—measured from the inferior margin of the symphysis to the anterior wall of the empty rectum and the perineal curvature—comes to:

<div style="margin-left:3em">

In new-born children ...   . $1\frac{1}{4}$ cm.

In virgins   ...   .   4 cm.

In women who have borne children ...   .   5 cm.

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These authors do not say how they arrived at their results, *i.e.*, whether they made their measurements on the living or on the dead, and if on the former under what conditions.

Piquand and Hue [25] and Hey Groves [13] have made measurements, independently, of the interval between the arms of the muscle at their origins from the pubic bones; the former found a separation of 25 to 30 mm., the latter one of 2 cm. The conditions under which the measurements were made are not stated; presumably they were taken on the dead.

Adolph [1] has made observations on the width of the pelvic floor aperture by testing the number of fingers that could be passed simultaneously side by side into it. He says:—" Einen geringeren Breitendurchmesser des Levatorspaltes als zwei Querfinger haben wir nach Gebturten nur selten angetroffen. Es scheint dies der Normal-befund bei der weitaus grössten Mehrzahl aller Frauen zu sein, die geboren haben." It is difficult or impossible to make measurements in virgins or in nulliparæ, because the uro-genital diaphragm in these is uninjured, and, being superficially placed, is in the way.

I have measured the length (*i.e.*, the antero-posterior diameter) of the pelvic floor aperture in the living in 39 cases, both at rest and during bearing down efforts, each patient lying on her left side. (For results, brief notes and methods used see Appendix.) The results show that on the average in the normal the length of the aperture is one and a half inches, and that on straining an increase of about half an inch occurs. When any substance is able to enter the aperture during straining the increase is greater, and may be considerable. It is obvious that such an increase will occur during defæcation as the fæcal mass is being extruded; and during parturition a similar, but much larger, enlargement, indeed an enormous distension, results; for both the rectum and the vagina leave the pelvis by passing through the pelvic floor aperture, and whatever distends these passages during its transit will correspond-ingly distend the muscle placed around them and cause an enlarge-ment of the aperture. The occurrence of this increase is best shown experimentally in cases of prolapse. I also found that on straining the increase in the length of the pelvic floor aperture is greater than the increase in the distance between the anus and the symphysis.

During this enlargement of the pelvic floor aperture, the result of the straining, the bladder, which is placed immediately above the

aperture and overlaps its borders for a considerable distance all round, is, it is plain, pressed more firmly downwards; and, although in the region of the aperture it is unsupported, yet laterally, in front and behind, it is still supported. Thus on each side it is compressed against the arms of origin of the pubo-coccygei; in front, against the broad surface formed by the upper and internal aspects of the pubic bones and symphysis; behind, against the upper part of the vagina, which itself is pressed against the rectum, and this in turn against the part of the pelvic floor behind the anus. This circumferential pressure is sufficient to prevent the bladder from being protruded through the pelvic floor aperture, enlarged by straining, provided this straining is not excessive and not too often repeated. This maintenance of the bladder is comparable to the maintenance within the pelvic cavity of the fundus of the uterus in those cases of partial prolapse of the uterus, in which the cervix is extruded and the organ considerably elongated. For whilst the pressure within presses out the cervix, the same pressure compresses the fundus against the pelvic floor, and holds it there with such force that the uterine body is coerced to stretch rather than to cause a descent of the fundus. This is Halban and Tandler's explanation. That there is a considerable tension between the fundus and cervix in these cases is shown by the fact that when the prolapse is reduced the elongation of the uterus, which this tension has caused, is within a very short time very much reduced as the sound easily demonstrates. That such retention of the fundus is not due to the connective-tissue attachments of the uterus is shown by the fact that with the displacement of the cervix the perivascular connective-tissue attaching it to the side walls of the pelvis has, in the majority of cases, similarly been displaced and stretched; whilst the retained fundus is only connected with the pelvic walls by the admittedly non-supporting broad ligaments, round ligaments, ovarian ligaments and their continuations the infundibulular ligaments, and the peritoneum. The possibility of such retention of the uterine fundus by pressure alone has been shown by Halban and Tandler experimentally by means of a phantom pelvis.

The same mechanism which maintains the fundus of the uterus within the pelvis whilst the cervix is expelled, and the uterine body consequently stretched and elongated, is also capable of maintaining the bladder in position during moderate straining. The size of the normal pelvic floor aperture during such straining is only 2 inches long or less, by about an inch, or a little more than an inch, broad; whilst the area of the bladder in relation to the pelvic floor and pubic bones, both antero-posteriorly and from side to side, is much more than this. If the pressure is excessive it causes the part of the bladder immediately above the aperture to bulge through, protruding the anterior vaginal wall before it, with the eventual formation of a

cystocele, which acts as a dilating wedge and causes an increasing enlargement of the aperture. It is plain this mechanism can more easily occur in cases in which the pelvic floor aperture is permanently widened by childbirth or other causes (*e.g.*, repeatedly recurring straining).

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APPENDIX.

APPENDIX: Being details of the methods used and the measurements
made of the length of the pelvic floor aperture in 39
cases, both at rest and during bearing down efforts, of
which 5 were taken both before and after labour, and
in 27 of which measurements over the superficial soft
parts covering the pelvic floor in the antero-posterior
plane were also taken, both with the patient at rest and
subsequently during straining. In all cases the patient
was lying on her left side.

1. Of the antero-posterior superficies covering the pelvic floor.

Three points were chosen, and for facility in noting were called
A, B and C. By A was designated the mid-point of the line joining
the two posterior superior iliac spines; B was placed at the mid-point
of the anus; C was the mid-point of the superior border of the
symphysis pubis. The tape was applied along the parts with its
beginning at C; endeavour was made to keep it fixed there in the
same place during the two readings in each case. BC was first read
off, and then AC. The patient was then asked to bear down, and the
measurements were again taken. No notice was taken of the
fourchette, nor of the length of the perineal base.

2. Of the antero-posterior diameter of the pelvic floor aperture.

A pair of specially constructed straight armed callipers, with
scale attached giving distances between the blunted ends in fractions
of an inch, was used. One arm was passed into the anal canal until
its end had reached its upper limit, as could be ascertained by passing
a finger into the lower part of the vagina. The end of the calliper
could be felt through the apex of the perineal body. In this
position it was immediately in front of the posterior commissure of
the pubo-rectalis muscle, being separated from it by the posterior
wall of the gut alone. In order to keep the instrument in position
and prevent it from slipping in too far a section of an ordinary cork
was previously slid upon the arm and adjusted about an inch or an
inch and a half—depending upon the depth of the anal cleft—from

its extremity. The instrument was passed with the patient lying upon her left side, and was held in the examiner's left hand. The thumb of the right hand was then placed on the mid-point of the inferior margin of the pubic arch and the right fore-finger upon the adjacent part of the antero-inferior surface of the symphysis. Between these two digits the extremity of the other arm of the callipers was adjusted, so that its end abutted upon the mid-point of the inferior margin of the pubic arch, and the greatest care was taken to maintain it there. The distance between the two arms was then read off. The instrument being maintained in this position, the patient was asked to bear down. On doing so the arms of the instrument were still further separated, and the measurements at the acme of the greatest excursion attained read off. The increase of the latter over the former gave the amount of the recession of the posterior commissure of the pubo-rectalis.

3. Comparison of increase of superficies with that of pelvic floor aperture on straining.

Since, in taking these measurements, the patient is asked to strain on two separate occasions—first, for the tape-measure, and, next, for the callipers—and since it is impossible to be certain the amount of straining in each is the same, it is scarcely possible to make comparisons between the two sets of measurements with anything like exactness; for such a purpose it would be necessary to make both measurements simultaneously, and that could not be done very easily. Moreover, even when the greatest care is taken, it is extremely difficult to get measurements along the soft parts with a tape true to one-eighth of an inch. Slight displacement of the tape to one or other side, and a different tension in the tape, cause considerable differences; and the length of the anal orifice is considerable, and it is not always easy to be sure the second measurement was taken at the same *point* as the first. Hence the measurements cannot be taken as absolutely correct, but endeavour was made to make them as correct as possible.

With this reservation the results of the two measurements may be compared, which brings out rather interesting points. It shows that on straining the increase in the length of the aperture is greater than the increase in the distance between the anus and the symphysis. This increase in the table is designated by BC, and is expressed in eighths of an inch. The increase in the size of the aperture is shown by the figure in the column on the extreme right, and is also expressed in eighths of an inch. The total (antero-posterior) increase of the soft parts superficial to the pelvic floor on straining is designated by AC, similarly expressed in eighths of an inch. It will be seen that in the majority of the cases (*i.e.*, in two-thirds of those in which both sets of measurements were made) that Ap.—the increase in the aperture on straining—is greater than BC—the

increase in the distance between the anus and symphysis on straining. The fact that this occurred in the majority of cases is, I think, sufficient to show that in those cases in which the reverse occurred that the straining was not so great when the measurement for the aperture was being taken as when BC was being estimated. (*e.g.*, Cases 33 and 34). And, on the other hand, since Ap. is in a few cases inordinately greater even than AC (as in No. 36), we may conclude that the straining when Ap. was being measured was much greater, or at least more effective, than when the tape measure was being used.

The greater length of the aperture on straining shows that the angle formed by the terminal part of the rectum proper (*i.e.*, intra-pelvic) and the anal canal, which at other times measures about a right angle, is correspondingly increased; *i.e.*, that the long axes of the rectum and anal canal tend to fall into the same straight line. During straining the down-thrust of the viscera causes the posterior commissure of the pubo-rectalis to recede and a corresponding enlargement of the aperture to occur. This posterior recession is greater during defæcation, and much more so during parturition, as the fæcal mass, on the one hand, and the ovum, on the other, is being extruded; as these pass they occlude the aperture.

I endeavoured to show graphically that the direction of the anal canal did change during bearing down, as these measurements show actually occurs; but I was unable to do so, for on straining the light lever I inserted into the anal canal was expelled. Since with the descent of the pelvic floor the position of the anus advances in relation to the descent of the ano-coccygeal raphe, as demonstrated by these measurements, they also show that the increase in the distance between the mid-point of the posterior superior iliac spines and the anus, consequent on bearing down, is determined, not by a stretching of the ano-coccygeal raphe, although this may occur to a slight extent, but is chiefly due to this alteration in the direction of the anal canal and to a stretching of the tissues which surround its terminal part, *i.e.*, skin, fat and external sphincter and muscle. This becomes most marked during parturition.

The measurements of the pelvic floor aperture also show that on the average in the normal the length of this aperture is $1\frac{1}{2}$ inch, and that on straining an increase of about half an inch occurs. When any substance is able to enter the aperture during straining the increase is greater and may be considerable. This is best shown in cases of prolapse. The value of the ring pessary was prettily demonstrated in Case No. 6, for whilst the ring was in place only a slight increment occurred, viz., 2 eighths, *i.e.*, $\frac{1}{4}$ inch; but when the ring was removed and the patient again strained an increase of nearly an inch was obtained. The ring prevented the entrance of the superimposed viscera into the aperture, and in this way safeguarded the pubo-rectalis from the pressure they would otherwise have caused,

and this protection allowed the inefficient muscle to occupy a position in which the length of the aperture during the dangerous period of straining measured $1\frac{3}{4}$ inches. When the ring was removed the viscera were extruded with a resulting enlargement. The result of allowing the prolapse to remain " down " is shown in Case 18, in which the aperture during rest measured $3\frac{1}{4}$ inches. Thus the value of the ring pessary is experimentally proved. The fact that no such change occurred on removing the ring in Case 27 shows that in this case the prolapse was cured, and it is probable that the patient might have left off using the pessary with safety, especially if means had been taken to reduce the volume of the abdomen and increase the efficiency of the muscles enclosing the abdomino-pelvic cavity by massage, exercise or electricity.

In the great majority of the cases no effect on the size of the aperture was obtained on coughing, only in one case (No. 12) in which labour was in progrss and the head was engaging the aperture, did coughing produce any result. In this case the longitudinal diameter of the aperture diminished by $\frac{1}{4}$ inch. In all cases, however, the muscle undergoes an increased contraction during coughing, as palpation readily demonstrates.

That the pelvic floor aperture does not usually diminish on coughing is explained by the fact that the increase of visceral pressure necessitated by coughing is transmitted through the pelvis along a line drawn at right angles to the centre of the plane of the pelvic brim, and strikes the pelvic floor in the region of the coccyx, considerably behind the pelvic floor aperture, anl only reaches the aperture by diffusion through the plastic visceral mass. Such increase of pressure is only momentary, as is shown by the manometer attached to a bag in the rectum, for on coughing the mercury shoots up to a great height, but drops as suddenly; and thus, owing to the position of safety adopted by the pelvic floor aperture and the plasticity of the visceral mass, escape of the viscera is prevented. The influence of excessive and frequent coughing in the production of prolapse is well known. When the visceral pressure becomes continuously increased, as occurs in pregnancy and in other conditions (corpulence), a corresponding hypertrophy of the pubo-rectalis (with a similar increase of the other parts of the pelvic floor, *e.g.*, ilio-coccygei) occurs.

AC signifies the increase of the antero-posterior superficies of the whole pelvic floor on straining.

BC signifies the increase of the superficies of the pelvic floor anterior to the anus in the sagittal plane on straining.

Ap. signifies the increase in the antero-posterior diameter of the pelvic floor aperture on straining.

These are expressed in eighths of an inch to facilitate comparison. The measurements of the antero-posterior diameter of the pelvic floor aperture, at rest, and during straining, are expressed in inches.

The numbers with the asterisk signify the cases in which measurements of the superfices were taken.

Pregnancy and Children and date of last child.	Disease, Condition, etc.	AC.	BC.	Aperture.	Ap
Multipara	——	—	—	$1\frac{5}{8}$ to $2\frac{1}{8}$	4
P. 5, C. 5, 1882 ...	Prolapse for 8 years since 1900, influenza and several bad coughing attacks.	—	—	2 to $2\frac{1}{2}$	4
. 5, C. 2, 1890 ...	Prolapse following confinement of first child 1887, getting steadily worse ever since.	—	—	$1\frac{7}{8}$ to $2\frac{1}{2}$	5
P. 5, C. 4, 1887 ...	Prolapse since third child, very stout. Interesting to notice the gradual increase of aperture on straining.	—	—	$1\frac{7}{8}$ to $2\frac{3}{8}$	4
P. 10, C. 9, 1901...	Womb came down after second child. Not stout, ring 18 years.	—	—	$1\frac{3}{4}$ to 3	10
P. 3, C. 3, 1903...	Prolapse dates from last confinement.				
	With ring in	—	—	$1\frac{1}{2}$ to $1\frac{3}{4}$	2
	With ring out...	—	—	$1\frac{1}{2}$ to $2\frac{3}{8}$	7
P. 10, C. 6	Fibroid.	—	—	2 to $2\frac{1}{4}$	4
. ...	? Fibroid.	—	—	$1\frac{1}{8}$ to $1\frac{1}{2}$	3
. ...	Prolapse. Abdomen full, girth 40 in., abdominal muscle good, no separation of recti, ring 14 years.	—	—	$2\frac{1}{4}$ to $2\frac{3}{4}$	4
P. 12, C. 10, 1908...	Rectocele and cystocele. "Bowels a trouble."	—	—	$2\frac{1}{4}$ to $2\frac{7}{8}$	5
para	Head in pelvis, labour in progress.	—	—	2 to $2\frac{1}{2}$	2
. ...	24 days after labour. Girth $28\frac{1}{2}$ in., slight separation of recti, right kidney plainly felt on deep respiration, left also; mentally defective, does not bear down properly.	7	—	$2\frac{1}{8}$ to $2\frac{1}{2}$	3
ipara	Head on floor, engaged in aperture. On coughing aperture reduces to $2\frac{1}{2}$ in.	—	—	$2\frac{3}{4}$ to $3\frac{1}{4}$	4
. ...	21 days after labour; persistent occipito-posterior position reduced by hand and forceps, considerable laceration of vagina and perineum. Complains bearing down pains; abdomen flat, muscle poor, considerable separation of recti $1\frac{3}{4}$ in., neither kidney felt (has only been up one day), girth $25\frac{3}{4}$ in., pelvic floor muscle felt best per rectum.	6	—	$1\frac{3}{4}$ to $2\frac{1}{4}$	4

Pregnancy and Children and date of last child.	Disease, Condition, etc.	AC.	BC.	Aperture.	Ap
para	Pregnant, head in pelvic cavity, os size of 2s. 6d.	—	—	$1\frac{3}{4}$ no chang straining	
. ...	21 days after labour. Girth 28 in., no separation of recti, neither kidney felt, rectum loaded; this explains why patient did not bear down well.	3	—	$1\frac{3}{4}$ to 2	2
P. 1...	Two months after labour, reputed weight of child 12 lbs., second stage very long, great posterior-rectal bulging. Prolapse. Abdominal muscle good, very slight separation of recti, girth $28\frac{1}{2}$ in.				
	First reading, August 21 1908	10	2	2 to $2\frac{7}{8}$	7
	Second reading, August 28 1908	9	4	$1\frac{1}{2}$ to $2\frac{1}{4}$	6
Primipara	Pregnant.	7	3	$1\frac{1}{2}$ to $2\frac{3}{8}$	7
P. 1, C. 1	22 days after labour. No separation of recti, girth 29 in., right kidney felt.	8	4	$1\frac{3}{8}$ to $2\frac{1}{2}$	9
. ...	Cystocele.	8	5	$1\frac{3}{4}$ to $2\frac{3}{8}$	5
P. 6, C. 6, 1894 ...	Prolapse for 2 years, winter cough for years. Very stout, girth $40\frac{1}{2}$ in., 3 in. separation of recti, not so strong as formerly.	16	4	$1\frac{1}{2}$ to $2\frac{1}{2}$	8
. 5, C. 5, 1883 ...	Prolapse posterior vaginal wall, no rectocele; first noticed 16 years ago, ring 8 years, since cup and stem pessary. Girth $34\frac{1}{2}$ in., no separation of recti, abdominal muscle good, pelvic floor muscle deficient anteriorly (most median and anterior fibres have disappeared), elsewhere remarkably good.	—	—	$3\frac{1}{4}$ to $3\frac{3}{4}$ or 4	4 6
P. 1	17 days after labour.	11	4	$1\frac{3}{4}$ to $2\frac{3}{8}$	5
. ...	Endometritis.	9	2	$1\frac{1}{2}$ to $2\frac{1}{4}$	6
Primipara	Pregnant.	8	3	$1\frac{1}{4}$ to $1\frac{3}{4}$	4
3, C 2, 1908... ...	——	10	3	$1\frac{1}{4}$ to $2\frac{1}{4}$	7
P. 4, C. 4	——	6	4	$1\frac{5}{8}$ to $2\frac{3}{8}$	6

Pregnancy and Children and date of last child.	Disease, Condition, etc.	AC.	BC.	Aperture.	A
Primipara	Pregnant. Girth 35 in., abdominal muscle good, $2\frac{3}{4}$ in. separation of recti (patient would not, or could not bear down). Muscle of pelvic floor very good (hypertrophied).	2	1	2	no chang strainir
C. 1	16 days after labour. Slight separation of recti, girth $28\frac{1}{2}$ in.	4	4	$1\frac{3}{4}$ to 2	2
P. 1	Labour 18 days ago. Girth $25\frac{1}{2}$ in., abdominal muscle good, no separation of recti, perineum intact, levator ani muscle very good condition, neither kidney felt.	7	4	$1\frac{5}{8}$ to $2\frac{1}{2}$	7
.. ..	Confined 20 days ago. Girth 28 in., no separation of recti, left kidney not felt; right kidney, lower pole and anterior surface felt, muscle of pelvic floor good, no perineal tear.	9	4	$1\frac{5}{8}$ to 2	3
P. 10, C. 9, 1886 ...	Prolapse. Abdomen voluminous, girth 33 in., $\frac{3}{4}$ in., separation of recti, abdominal muscle pretty good, pelvic floor muscle fair. Ring was now removed, parts again measured; no protrusion, and little change in measurements; standing erect, lower abdomen is pouched.	9 / 9	3 / 4	$1\frac{3}{4}$ to $2\frac{3}{8}$ / $1\frac{3}{4}$ to $2\frac{1}{2}$	5 / 6
P. 2, C. 2, 1905 ...	Prolapse since 6 weeks after first child. Girth $22\frac{1}{2}$ in., recti separated $\frac{3}{4}$ in., abdominal muscle not good; anal cleft a wide, shallow groove, patient very thin; pubo-rectalis pretty good, ilio-coccygei poor, can scarcely feel it contract on coughing.	10	5	$1\frac{1}{2}$ to $2\frac{1}{4}$	6
P. 10, C. 2, 1908 ...	Girth $27\frac{3}{4}$ in., abdominal muscle good, slight separation of recti.	4	0	$1\frac{7}{8}$ to $2\frac{3}{8}$	4

Pregnancy and Children and date of last child.	Disease, Condition, etc.	AC.	BC.	Aperture.	Ap
P. 9, C. 8, 1890 ...	Prolapse. Girth 27 in., abdomen pouched, muscle not good, recti separated on raising head 1 in., pelvic floor lowered, anal cleft shallow, pubo-rectalis fairly good, ilio-coccygei very poor indeed, right kidney felt, not left; ring 11 years.	11	7	$1\frac{1}{2}$ to $2\frac{3}{8}$	7
	With ring out...	—	—	$1\frac{1}{2}$ to $2\frac{5}{8}$	9
P. 1, C. 0, 1907	Pregnant. Abdominal muscle pretty good, no separation of recti, girth $27\frac{3}{4}$ in., lower pole right kidney felt, not left.	8	2	$1\frac{3}{4}$ to $2\frac{3}{8}$	5
P. 2, C. 2, 1908 ...	Girth $29\frac{1}{2}$ in., abdominal muscle soft and yielding, very slight separation of recti.	5	4	2 to $2\frac{5}{8}$	5
P. 6, C. 6, 1904 ...	Retroversion. Pelvic floor muscle very good, pubo-rectalis in excellent condition.	8	4	$1\frac{1}{4}$ to $1\frac{5}{8}$	3
Nullipara	Hypertrophied right labium minus. Abdominal muscle good, no separation of recti, girth 27 in., lower pole right kidney felt on deep respiration, left not palpable.	9	4	$1\frac{1}{2}$ to $1\frac{7}{8}$	3
P. 2, C. 2, 1905 ...	Retroversion and erosion. Girth 31 in.	4	2	$1\frac{1}{2}$ to $1\frac{7}{8}$	3
P. 3, C. 3, 1887 ...	Girth 34 in., abdominal muscle good, on standing erect abdomen considerably pouched, pelvic floor feels as thought it has been considerably stretched.	5	3	$1\frac{3}{4}$ to $2\frac{7}{8}$	9
P. 16, C. 15	————	—	—	2 to $3\frac{1}{8}$	9
C. 1	Pregnant 7 months. Girth $33\frac{1}{2}$ in., some separation of recti $1\frac{1}{4}$ in., anal cleft shallow, descent of whole pelvic floor, prolapse of posterior vaginal wall (strained very hard, with passage of flatus); muscle of pelvic floor in good condition, on straining it descends considerably.	7	6	$1\frac{7}{8}$ to 3	9
Primipara	Pregnant. Girth $33\frac{3}{4}$ in.	6	2	$1\frac{5}{8}$ to $2\frac{1}{8}$	4