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The Principles that should Underlie all Operations for Prolapse*

BY

VICTOR BONNEY, M.S., M.D., B.Sc. (Lond.), F.R.C.S. (Eng.).
F.R.A.C.S.

Gynaecological Surgeon to the Middlesex Hospital.

It is highly desirable that some consensus should be reached as regards the intimate mechanism of prolapse, for until this is achieved the present wide diversities of opinion as to the best method of operative cure will continue to exist.

To begin with, I would postulate that prolapse is a purely vaginal phenomenon, in the causation of which the uterus does not play any direct part but acts more or less as a deterrent. The vagina, in its relation to the peritoneal cavity, is in exactly the same position as the in-turned finger of a rubber glove, which we out-turn by closing the mouth of the glove and compressing the air locked in it. In both cases there is a cul-de-sac intruding into a closed cavity, the pressure within which is liable to a sudden rise. In the instance of the rubber glove the pressure is purely gaseous and depends on the amount of force applied by the hand compressing it. The intra-abdominal pressure is more complicated, depending as it does partly on the gas-pressure in the intestines, partly on the muscular contraction of the parietes, and partly on the weight of the movable viscera. Of these three components the first acts equally in all directions, the second more often towards the pelvis than towards the diaphragm, while the third, being dependent on gravity, acts downwards, and as a result the parietes of the lower part of the peritoneal cavity are

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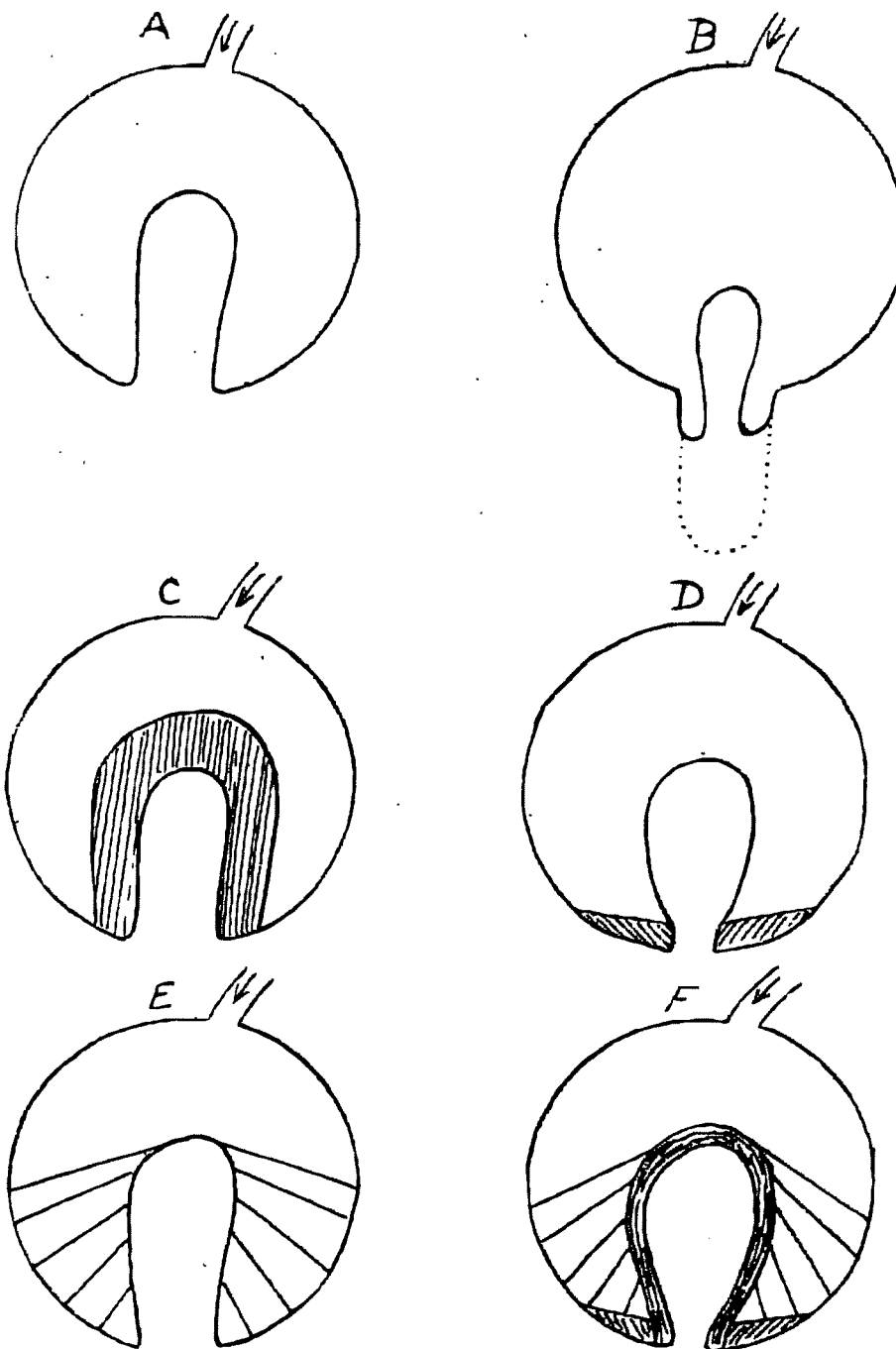


FIG. 1.

Diagram of a cul-de-sac intruding into an artificial gas-containing cavity, the pressure in which can be raised, showing the various measures that could be taken to prevent the cul-de-sac turning inside out.

- (A) An artificial gas-containing cavity into which a cul-de-sac with pliable walls is intruded. Gas can be pumped into the cavity through the tube shown at the top.
- (B) When the pressure of the cavity is raised the cul-de-sac is turned inside out.
- (C) The wall of the cul-de-sac greatly thickened.
- (D) The orifice of the cul-de-sac narrowed by a circular thickening.
- (E) The wall of the cul-de-sac attached to the wall of the gas-containing cavity by a series of threads.
- (F) A combination of these devices.

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in the standing, sitting, and squatting postures more exposed to a stretching force than the parietes of the upper part.

The compound nature of the intra-abdominal pressure does not, however, affect the analogy I suggest between the glove-finger intruding into the closed cavity of the glove and the vagina intruding into the closed cavity of the coelom: in either case the cul-de-sac is exposed to a pressure tending to turn it inside out. In the case of the glove it does so readily. Why does it not do so in the case of the normal vagina?

MECHANICAL CONSIDERATIONS.

As an approach to the problem let us first take the case of an artificial cul-de-sac intruding into an artificial closed gas-containing cavity (Fig. 1a) and consider what steps could be taken to prevent the cul-de-sac turning inside out when the pressure in the closed cavity was raised (Fig. 1b).

1. Since the ease, or otherwise, with which a cul-de-sac can be turned inside out depends largely on the resistance of its wall and the relation between the thickness of the wall and the calibre of the lumen, turning inside out of our artificial cul-de-sac could be prevented either by making its wall rigid or by thickening it so much in relation to the calibre of its lumen that turning inside out would be impossible, as in the case of a piece of pressure-tubing (Fig. 1c).

2. If the outlet of the cul-de-sac was sufficiently narrowed, complete turning inside out would be rendered impossible, for though the cul-de-sac might collapse down as far as the constriction it could not pass through it. This is really a special case of the general principle enunciated under 1 (Fig. 1d).

3. If the cul-de-sac instead of being straight was sharply bent, the effect of raising the pressure in the closed cavity would be to increase the bend and make turning inside out more difficult or impossible.

4. The out-turning effect could be combated by attaching the wall of the cul-de-sac to the wall of the closed cavity, either directly or by some intermediary structure, as for example a series of threads (Fig. 1e) or by a combination of the devices mentioned (Fig. 1f).

When we come to consider that which obtains in the case of the vagina and uterus we find that Nature has anticipated us in all these devices.

THE SUPPORTING MECHANISM OF THE VAGINA.

The lower third of the vagina is fixed to the margins of the levator muscles and the fasciae in relation to them. The upper

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two-thirds, however, lies above the pelvic floor and, therefore, requires a separate supporting mechanism. This takes the form of two fan-shaped expansions of fibromuscular tissue, which, arising on each side along the whole length of the lateral vaginal walls above the levator diaphragm as high as the supravaginal cervix, are inserted into the fascia covering the side walls of the pelvis along the lines of attachment of the levatores ani muscles. The description "fan-shaped," however, does not fully describe them, as the fans are curved with a concavity downwards and backwards, especially towards their posterior margins. Various names have been given to these structures—Mackenrodt's ligaments, the transverse ligaments, the utero-sacral ligaments, the cervico-pelvic ligaments—but I think it is generally agreed that the name best suited to them is the cardinal ligaments of the vagina. Certain authors have split them up into two or even three sections, but I have never been able to observe such, although I have isolated them in the living some 500 times. Both when felt by the fingers and during their division by scissors they appear to be unbroken sheets of tissue. The description of them as perivascular sheaths is altogether wrong, for they not only lie considerably below the uterine arteries as the latter proceed from the hypogastric arteries to the sides of the uterus, but they contain no vessels to speak of. I can only suppose that those who so labelled them had never really seen them.*

The cardinal ligaments attach the vagina to the side wall of the pelvis, and are the main structures holding the upper two-thirds of the canal in its normal position.

The back and front walls of the vagina from the pelvic diaphragm upwards are covered by layers of fascia. That on the back wall is thin and relatively of little account, but that on the front wall is a structure of some importance, for it consists of fibres of unstriped muscle which extend forwards in a fan-like manner from the front of the supravaginal cervix, to be attached centrally to the back of the subpubic ligament and the block of tissue which surrounds the urethra,† while laterally on each side they spread out over the upper and anterior surface of

* The cardinal ligaments can only be properly studied in the living. Dissecting-room preparations and frozen sections are useless. Moynihan pointed out that the "pathology of the living" often differed from the "pathology of the dead." In the case of the pelvis, at all events, the anatomy also differs. He who has not performed Wertheim's operation and abdomino-perineal excision of the rectum has never fully explored the pelvis.

† I have called it the peri-urethral wedge.

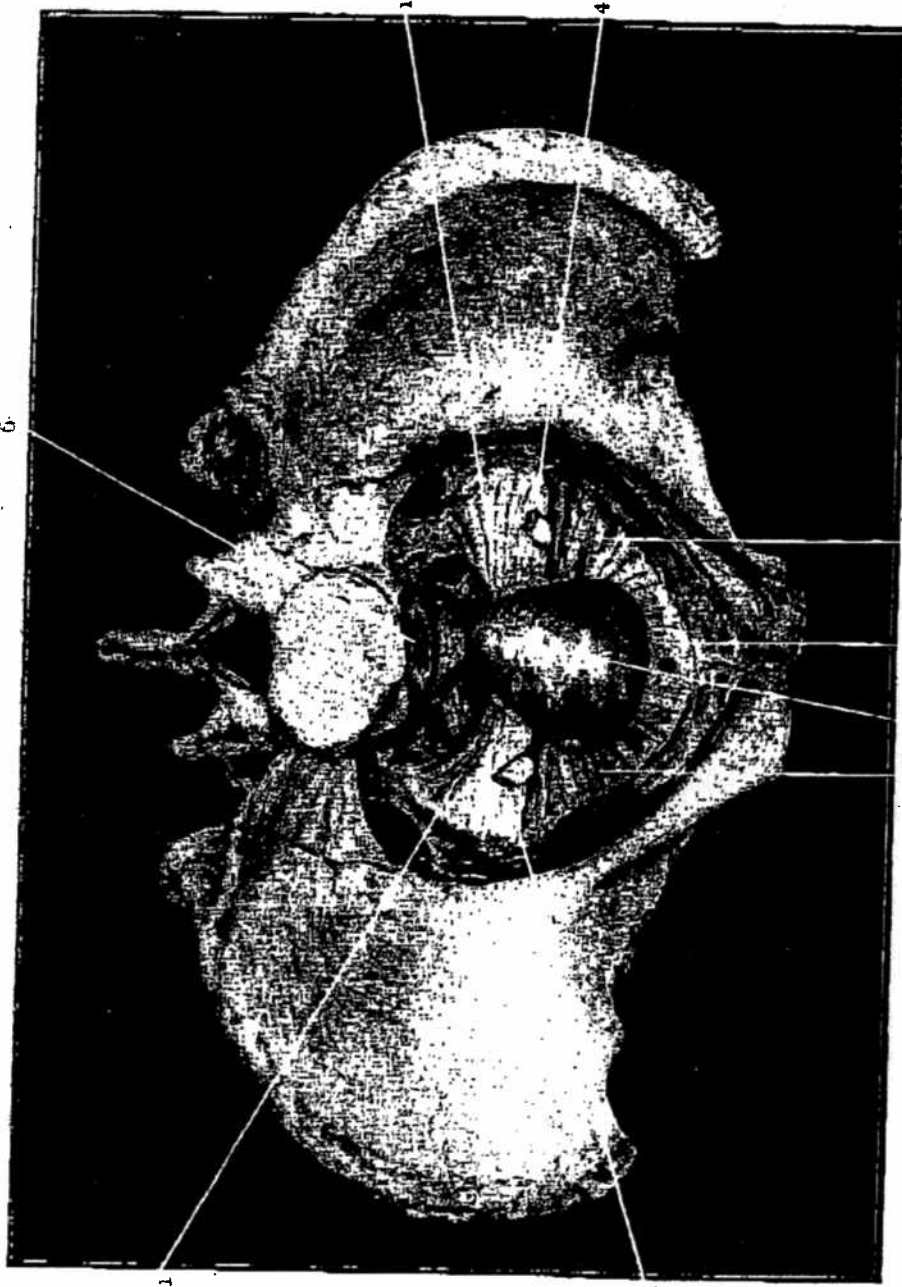


FIG. 4. Photograph of a model of the pelvis showing the "pelvic shell."

- 1—Posterior portions of cardinal ligaments.
- 2—Pubo-cervical fascia overlying them.
- 3—Aperture through which the urethra passes.
- 4—Ureters passing into uterine canals.
- 5—Anteflexed body of uterus.
- 6—Rectum.

Note.—The emergence of the ureters from the uterine canals is hidden by the body of the uterus.

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the cardinal ligaments, and, crossing over the ureters, form the roofs of the ureteric canals. They form what is known as the pubo-cervical or sub-vesical fascia, the function of which is to strengthen the anterior vaginal wall and make it more resistant to pressure applied to it through the utero-vesical space and the bladder. The cervix and vagina, together with the cardinal ligaments and pubo-cervical fascia, form a figure which may be likened to an insect to whose elongated body are attached on either side two wings, practically superimposed on one another, but of which the undermost is much the thicker and stronger.

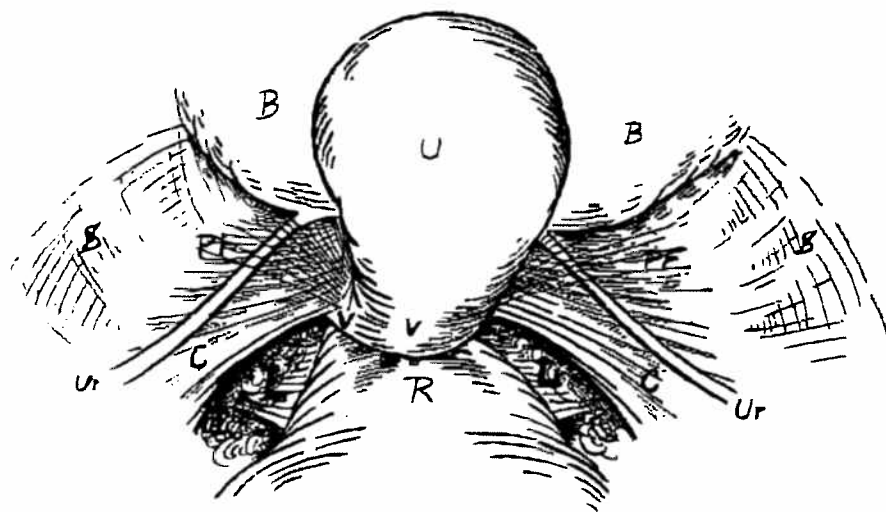


FIG. 3.

Diagram to illustrate the "pelvic shelf":

u—uterus; bb—bladder; vv—vagina; r—rectum; cc—cardinal ligaments; pf—pubo-cervical fascia; ll—lateral ligaments of the rectum; es—side walls of the pelvis; ur—ureters.

The uterine corpus in this analogy would stand for the head of the insect. Since all but the posterior edges of the wings are attached to the front and side walls of the pelvis, the result is a shelf-like structure projecting half-way across the pelvic cavity from before backwards. On the upper and anterior surface of this shelf rest the bladder and ureters, while its lower and posterior surface is opposed to the rectum in the middle line and laterally to two masses of fibro-fatty tissue that separate it from the lateral rectal ligaments (Figs. 2 and 3).

The genital canal from the top of the uterus downwards forms a curve with its concavity forwards. The curve is most marked at the upper end where the uterus bends forwards on the vagina,

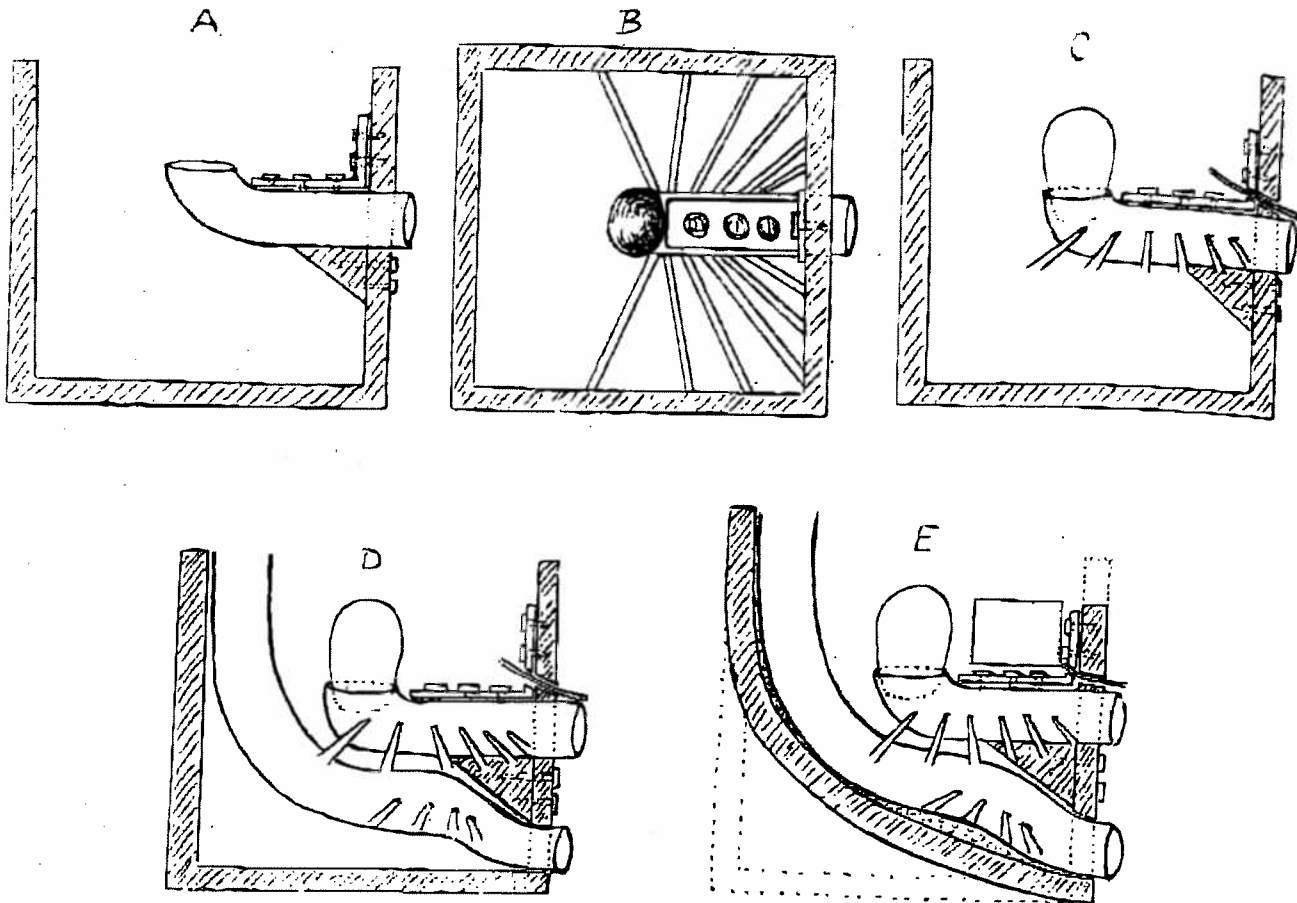


FIG. 4.

The mechanical arrangement of the pelvis can be illustrated by the following parable: A mechanic desires to fix a piece of stove-pipe in a large empty box. He bores a hole through the front wall of the box and passes one end of the pipe through it. He finds, however, that it is not secure. He therefore proceeds to fix underneath it a triangular block of wood which bolts into the front wall of the box, and also fixes an angle-iron above the pipe and bolts it both to the front wall of the box and the upper surface of the pipe (A). The fixation still not proving entirely satisfactory, he carries out a series of struts from the sides of the pipe to the side walls and the front wall of the box (B). He then bores a hole through the angle-iron and front wall of the box above the pipe and passes a small tube through it, and further fits a large plug in the upper end of the piece of stove-piping (C). He now desires to fix a second piece of stove-piping underneath the first piece and bores another hole in the front wall of the box and passes one end of the pipe through it, and further carries out a series of struts from the side of this second piece of pipe to the side walls and front wall of the box in the same way that he did in the case of the first pipe (D). The fixation not proving sufficiently firm, he then cuts away the lower half of the back wall of the box and the whole of its floor and replaces the parts removed by a curved piece of wood, to which he cements the second pipe. Finally he rests on the top of the angle-iron and the struts supporting the first piece of piping a small cistern, which he connects up with the tube passing through the angle-iron (E). The final result illustrates the arrangement of the pelvis: The first piece of stove-pipe is the vagina, and the triangular block of wood is the perineal body. The angle-iron is the pubo-cervical fascia. The plug is the uterus. The tube passed through the angle-iron is the urethra. The struts lateral to the first pipe are the cardinal ligaments. The second piece of stove-piping is the rectum. The struts attached to the second piece of piping are the lateral ligaments of the rectum. The curved piece of wood and the front wall of the box represent the sacrum, the coccyx, the pelvic floor and the symphysis pubis. The analogy must not, of course, be pushed too far.

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and at the lower end where the interposition of the perineal body deflects the vagina forwards, away from the rectum. All the structures attached, or in juxtaposition, to the canal play some part in maintaining this curve, but the main agents are the cardinal ligaments, the levator muscles and the perineal body. The net result is an exceedingly ingenious natural mechanism against the tendency for the vagina to be turned inside out when the intraperitoneal pressure is raised (Fig. 4).

THE EFFECT OF THE INTRA-ABDOMINAL PRESSURE.

In normal circumstances in the standing, sitting or squatting posture, the bulk of the intestines in the pelvis lies behind the uterus and the upper part of the vagina, and when the intra-abdominal pressure is raised by any effort further coils of intestine are forced into the same situation; indeed, in this respect the utero-rectal space may be regarded as a natural hernial sac. The resultant of the intra-abdominal pressure, or what I will call its axis of effect, is therefore expended in forcing the uterus and the upper part of the vagina forwards and compressing the rectum against the unyielding sacrum behind* (Fig. 5).

The pressure during straining is, further, not only exercised on the back of the upper vagina and uterus, but by the medium of the loose tissue behind the cardinal ligaments on the back of those ligaments themselves, with the result that the whole pelvic shelf is pushed forwards and tautened, and even perhaps slightly raised, and this effect is probably heightened by contraction of the many unstriped muscle-fibres which the cardinal ligaments contain.

It is apparent, therefore, that Nature has taken very much the same steps that a mechanician would take to prevent a cul-de-sac intruded into a closed cavity from turning inside out when the pressure in the cavity was raised. The one difference is that she has not made the vaginal wall rigid and has left it thin in comparison with the calibre of its lumen. Instead she has strengthened the lateral walls by making the cardinal ligaments take off from them, reinforced the anterior wall by a sheet of muscular fascia, placed the posterior wall up against the rectum and arranged that the front and back walls lie in apposition and so support one another.

* In visualizing this action it is necessary to bear in mind the almost right-angle turn forwards that the rectum makes below the level of the peritoneum of the pouch of Douglas.

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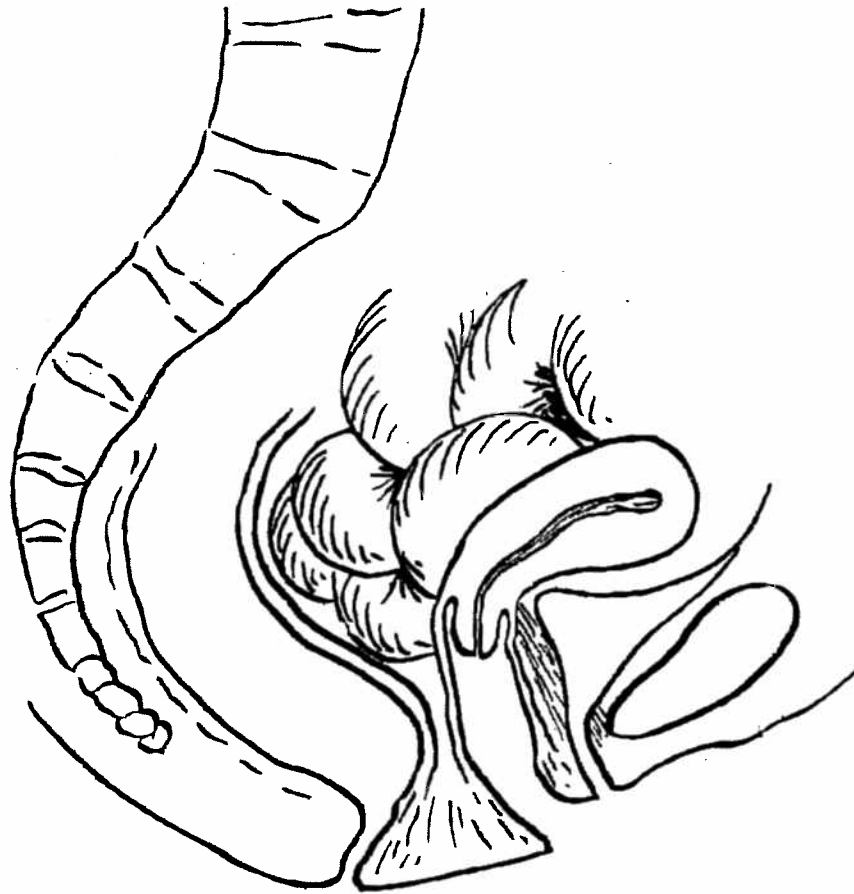


FIG. 5.

The uterus and vagina in anteversion with the "axis of effect" of the intra-abdominal pressure normally directed.

THE SUPPORTING MECHANISM OF THE UTERUS.

The uterus itself is held in position chiefly by the upper fibres of the cardinal ligaments, especially those that form the most posterior part of the fan (sometimes called the utero-sacral ligaments) and the fibres of the pubo-cervical fascia. These, however, fix the cervix only. The corpus is steadied rather than held by the broad ligaments, which may be likened to the guy-ropes of a tent, the inset of the cervix into the vagina representing the point where the tent-pole is driven into the ground. To make up for these relatively weak attachments to the parietes Nature has given the uterus walls so thick that turning inside out is impossible except in very exceptional circumstances, inversion of the uterus being the uterine homologue of prolapse.

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INCREASE IN THE CALIBRE OF THE LUMEN OF THE VAGINA WITHOUT PROPORTIONAL INCREASE IN THE THICKNESS OR STRENGTH OF ITS WALL.

Childbirth, by permanently enlarging the calibre of the vagina without a corresponding increase in the thickness or rigidity of its walls, makes inversion of the vagina more easy, and the more so the more the passage is enlarged. Not only is this so, but the wall is often left weaker owing to the permanent deterioration of the stretched tissues, and the same is true of the supporting structures. This has an important bearing on operative treatment, for the surgeon has more or less to over-correct the deformity to compensate for the unalterable tissue-change. Disproportion between the thickness of the wall and the calibre of the lumen can be coped with in one of two ways—the lumen may be reduced, or the wall thickened. Reduction of the lumen by cutting away more or less of the vaginal wall is a feature common to most operations for prolapse, and indeed any case of prolapse could be cured by the simple expedient of cutting away so much vagina that its wall, relative to the much-reduced lumen, becomes too thick to be turned inside out. It is only in old women, however, that such is permissible. The *rationale* of Le Fort's operation is largely this. There is only one operation I know of in which the vaginal wall may be said to be deliberately thickened, and that is the interposition operation in which the body of the interposed uterus can be regarded as greatly thickening the anterior vaginal wall.

YIELDING OF THE ATTACHMENTS OF THE WALL OF THE VAGINA TO THE ABDOMINAL PARIETES.

The vagina has two main attachments to the parietes. Its upper two-thirds is indirectly attached by means of the cardinal ligaments, while its lower third has a direct attachment to the levator diaphragm and the fasciae in connexion with it.

Yielding of the cardinal ligaments. Laxity of the cardinal ligaments produces retroversion of the vagina (Fig. 6). I drew attention to this displacement some years ago. It is curious that it had remained unnoticed so long, for it is very easily recognized if attention be paid to the axis of the canal. Not only does the vagina retrovert, but the whole pelvic shelf does likewise, so that the utero-vesical space is opened up. The cervix goes back with the vagina, but if the broad ligaments are sufficiently resistant the body of the uterus may remain ante-flexed. A uterus that is

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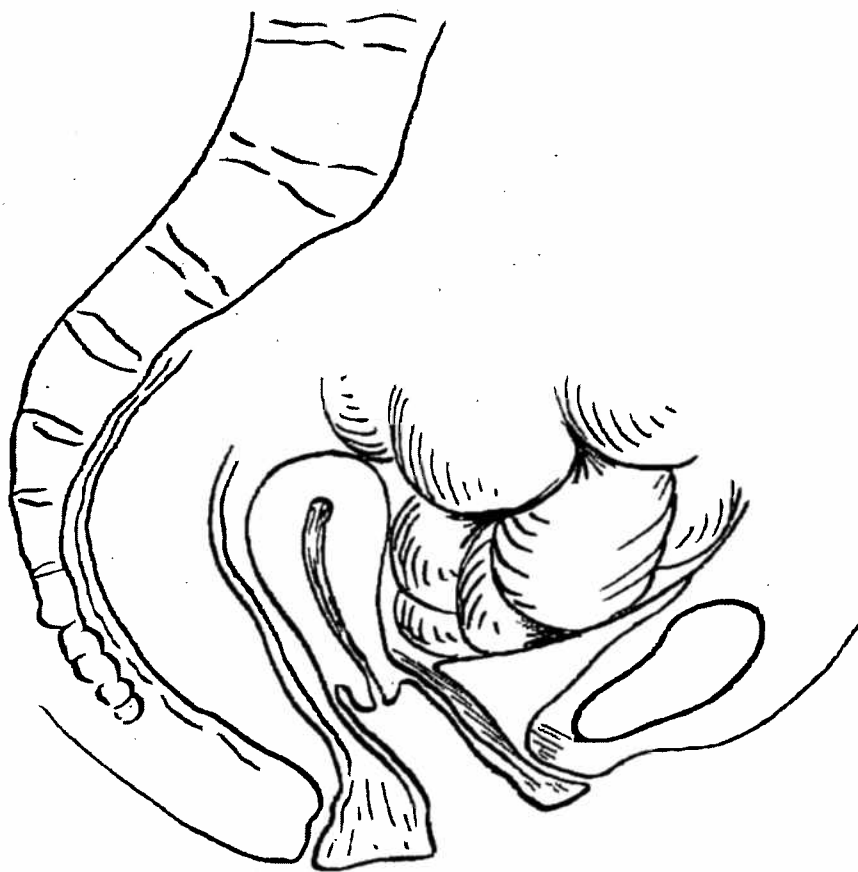


FIG. 6.

Retroversion of the vagina. The "axis of effect" of the intra-abdominal pressure directed in front of it.

retroverted and ante-flexed is sometimes described as being "retroposed." Vaginal retroversion frequently exists unaccompanied by any other form of displacement. Owing to the alteration in the vaginal axis the anterior vaginal wall becomes abnormally visible and cystocoele is often mistakenly diagnosed. but on prising the vagina forwards, it will be found that the supposed cystocoele disappears. Retroversion of the vagina in itself probably causes few, if any, symptoms, but it is, as I shall show, a step towards prolapse of the anterior vaginal wall. Operative correction of the displacement, to be strictly anatomical, should effect a tautening of the cardinal ligaments and the whole of the pelvic shelf, but this is difficult to effect because the cardinal ligaments are inaccessible from the abdomen short of a severe

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operation* and, except the upper fibres, are still more inaccessible from the vagina. The most obvious way to correct vaginal retroversion is by ventral fixation of the uterus, which pulls up the whole shelf.

Yielding of the pelvic floor. Laxity of the levator diaphragm and the fasciae in relation to it permits the inferior abdominal parietes to bulge downwards when the intra-abdominal pressure rises. Bulging of the levator diaphragm and the other structures comprising the inferior abdominal parietes does not directly cause prolapse, but it creates a drag on the vagina, the lower end of which is attached to it. This drag is resisted by the cardinal ligaments and the other sustentacular apparatus above the pelvic floor, and as a result the posterior vaginal wall becomes stretched, and permanently elongated and finally protrudes to form that variety of "rectocele" which is not accompanied by any bulge or displacement of the rectum.

Normally, the vagina is narrowest where it passes through the inferior abdominal parietes, the constriction being due to the presence of the perineal body and the edges of the levatores, and this narrowing is increased when, in response to a sudden rise in intra-abdominal pressure, the levatores contract. In weakness of the pelvic floor, however, accompanied as it usually is by deficiency of the perineal body, this arrangement is altered so that the constriction no longer exists. As a result the lower end of the posterior wall no longer makes contact with the lower end of the anterior wall, so that one part of the mechanism which sustains the anterior wall from the effect of the intra-abdominal pressure is missing and it is in danger of being bulged in. Moreover, the sharp forward curve of the lower end of the vagina is lost and the posterior wall, if it bulges, does not meet with any resistance. Repair of the pelvic diaphragm and perineal body and restoration of the normal bottle-neck shape to the lower end of the vagina should be a feature of all operations designed to cure prolapse affecting the anterior or posterior vaginal walls.

ON THE AXIS OF EFFECT OF THE INTRA-ABDOMINAL PRESSURE.

The axis of effect of the intra-abdominal pressure normally acts, as I have shown, behind the uterus and upper vagina, so that more pressure is exerted on the rectum and posterior vaginal wall than on the bladder and anterior vaginal wall. The rectum and posterior vaginal wall are sustained against the pressure not

* The late Arthur Nyulassy devised an abdominal operation.

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only by the ligaments in connexion with them, but also by their sharp curves forwards, while the rectum in addition is supported by the unyielding sacrum. When the intra-abdominal pressure is excessive relative to this mechanism the pressure either bulges in the upper part of the vaginal wall and forces the peritoneal cul-de-sac downwards into the recto-vaginal septum, or else it pushes the rectum down on the face of the sacrum so that it buckles forwards carrying the posterior vaginal wall with it. Three types of so-called "rectocele" may, therefore, be distinguished. The first is a true hernia of the pouch of Douglas; the second is a buckling forwards of the rectum accompanied by an inward bulge of the middle part of the posterior vaginal wall; and the third is a bulge, similar in appearance to the second, but unaccompanied by any shift in the position of the rectum. The first and second of these three are the direct result of the intra-abdominal pressure, but the third is only indirectly so, or being the result of yielding of the pelvic floor. To put it another way: the first two are caused by pressure from above but the third by dragging from below. The first two can occur in the absence of defect in the pelvic floor, but the third cannot.

The axis of effect of the intra-abdominal pressure may, however, be directed in front of the uterus and vagina, instead of behind them. Such misdirection is due to retroversion of the vagina (Fig. 6), especially when combined with retroversion of the uterus. The effect of this displacement is to open up the utero-vesical space until a larger proportion of the intestines lies between the uterus and the back of the symphysis than between the uterus and the sacrum. In these circumstances abnormal pressure is exercised on the anterior vaginal wall and the whole of the upper and anterior surface of the pelvic shelf. As a result, during strain the vagina and cardinal ligaments are pressed backwards instead of forwards, and the anterior vaginal wall and the underlying pubo-cervical fascia are in danger of being bulged in.

The surgical corollary to these considerations is that any operation for prolapse which leaves the axis of effect of the intra-abdominal pressure still wrongly directed is faulty. In those forms of prolapse in which the condition is due to the pressure acting excessively but in the normal direction, steps can be taken to diminish its incidence by obliterating the pouch of Douglas by suturing the bowel to the back of the uterus. This is a very effective treatment of rectal prolapse, the mechanism of which is fundamentally the same.

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ON THE POSITION OF THE INITIAL BULGE.

When a cul-de-sac begins to turn inside out the first thing which happens is a bulge of its wall into its lumen. In the case of perfectly free sac like the inturned glove-finger, which I have cited as illustrating the fundamental nature of prolapse, the bulge occurs circularly round the glove-finger at its junction with the hand of the glove. The vagina, however, is not a perfectly free sac, although in very extreme prolapse (especially when the uterus has been removed) it behaves very nearly as though it were. I am concerned, however, not with the extreme but with the early phases of the condition, and in such the initial bulge affects either the anterior wall, the posterior wall or the vault. The lateral walls are never the seat of it because the cardinal ligaments fix them for the greater part of their length, while at their lower end their attachment to the pelvic diaphragm has the same effect. For the same reason the lateral parts of the vault escape, and so also does the extreme lower end of the posterior wall on account of its firm attachment to the perineal body. The particular part, or parts, of the wall at which the bulge first occurs (for the initial bulge may be multiple) depends upon which part of the sustentacular mechanism gives way before the intra-abdominal pressure. Accompanying the bulge there is a stretching of the bulged wall, the amount of which depends on the degree to which the bulge is resisted by the parts not yet displaced. The result is that in nearly all cases of prolapse the surface area of the vagina as a whole is augmented by the increase in the area of the bulged-in portion. This has an important bearing on operative treatment, for it compels the surgeon to excise a portion of the wall, the portion excised usually corresponding to that part of the wall, the area of which has been augmented by the bulge.

The anterior wall. There are two positions on the anterior wall at which the initial bulge may occur. The first is that corresponding to the base of the bladder, when the bulge is called a "cystocoele" (Fig. 7b); while the second affects the extreme lower end of the wall and produces the deformity that accompanies stress incontinence of urine (Fig. 7c).

The vaginal vault. There are three positions on the vaginal vault at which the initial bulge may occur. In the first the whole of the vault bulges in (Fig. 7d). The movement is resisted by the uterus in proportion to its size and the integrity of its supports, with the result that if the resistance is sufficient the dragged-upon supravaginal cervix elongates. The vaginal cervix should be

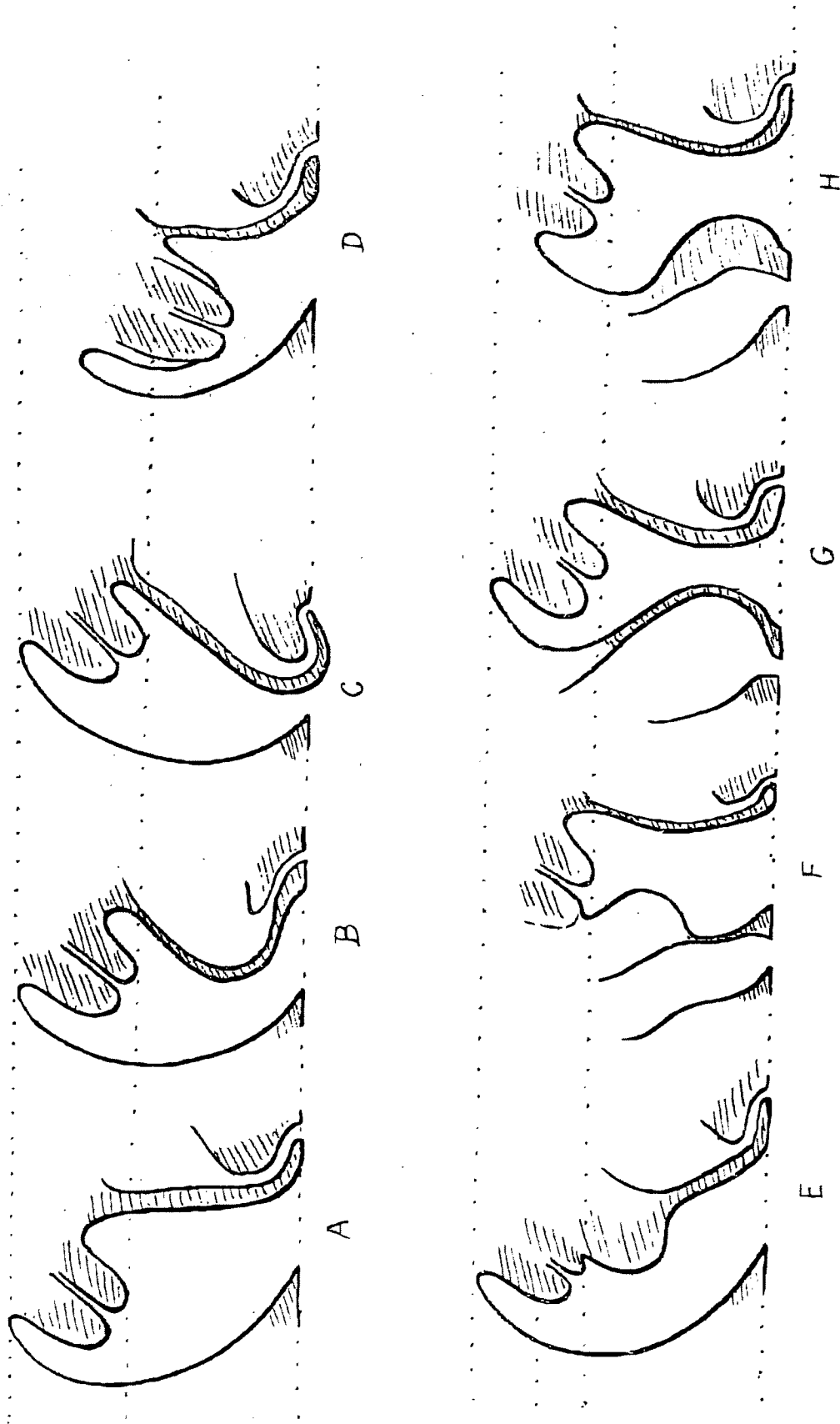


FIG. 7.

The several forms of prolapse:

A series of diagrams to illustrate the various positions in which the initial bulge of the vaginal wall may be situated. (A) Normal. (B) Cystocele. (C) The displacement of stress incontinence. (D) Prolapse of the whole vault. (E) Prolapse of the anterior vault. (F) Prolapse of the posterior vault. (G) Rectocele accompanied by the rectum. (H) Rectocele without displacement of the rectum.

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regarded as forming part of the vaginal vault, just as in architecture the *boss* forms the central part of a vaulted roof, and when it is cut away the result is a reduction in the area of the vault. As in cases of complete vault-prolapse the area of the bulged-in vault is abnormally large, the removal of the vaginal cervix is a correct procedure. The principal finds its application in Fothergill's operation.

In the second position only the anterior part of the vault is affected, the area corresponding to the cellular interval between the posterior vesical and anterior cervical walls so that the protrusion is above the bladder (Fig. 7e).

In the third position only the posterior part of the vault is affected; constituting a "rectocele" which is in effect a hernia of Douglas's pouch (Fig 7f).

The posterior wall. Finally, on the posterior vaginal wall there is only one position, namely that corresponding to the recto-vaginal septum. To the bulge the term "rectocele" is also applied. I have already pointed out that there are two varieties of rectocele in this situation (Fig. 7, g and h), only one of which involves the bowel.

Wheresoever the initial bulge takes place, as it enlarges it tends to drag more and more of the vaginal wall into its area and makes increased demands on that part of the supporting mechanism which still functions. If this gives way progressively the bulge spreads until in the end the whole vagina becomes extroverted.

CONCLUSIONS.

The conclusions to be drawn from these considerations are, I think:

1. That the intra-abdominal pressure when it rises above atmospheric pressure tends to turn the vagina inside out.
2. That this tendency is countered by a mechanism made up of several factors.
3. That prolapse is due to the failure of this mechanism, either in whole or in part.
4. That there are several forms of prolapse.
5. That the form depends upon which part of the sustentacular mechanism has failed.
6. That no operative treatment is ideal which does not take into account and rectify or abrogate all the factors responsible for the particular deformity, and that, therefore, no one procedure is a panacea for all cases.