AN ANATOMICAL REVIEW OF VARIOUS DESCRIPTIONS OF THE FASCIAL AND MUSCULAR VISCERAL SUPPORTS OF THE FEMALE PELVIS, INCLUDING BOTH THE EXTRINSIC AND INTRINSIC MUSCULATURE OF THE URETHRA.

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by

The Nature and Origin of Connective Tissue.

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Conclusion.
"The connective tissues of the body, derived from the mesenchyme, include several different types of tissue, among them areolar tissue, adipose tissue, white fibrous and yellow elastic tissue. In any connective tissue the parent cells are separated more or less widely from one another by a homogeneous matrix or ground-substance, in which fibres may or may not be present.

The cellular elements include spindle shaped fibroblasts, phagocytic histiocytes, and plasma cells, the latter notably as a result of inflammation. The fibres are of two kinds - white collagenous fibres, wavy, nonbranching, and usually disposed in bundles, and yellow elastic fibres, branching and interconnecting.

The different types of tissue are distinguished by variations in either matrix or cells. In areolar tissue, a light spongelike lacy tissue, both white and yellow fibres form a loose irregular meshwork, and the cellular elements are scattered. Adipose tissue consists of fat cells, lodged in the meshes of areolar tissue. White fibrous tissue forms inelastic tendons, ligaments, and tough investing membranes or fasciae. The white fibres predominate, and in a fascial membrane their bundles intersect whereas in a ligament they run parallel to one another. (According to Ricci et al. (1947) and Grant (1948), the white fibrous bundles in a fascia also have a parallel disposition.) In yellow elastic tissue, fibres of the same name have developed to the practical exclusion of other elements. It is found throughout the body in certain coats, the elastic laminae, of blood vessels, especially the large arteries, and in other parts.

Few blood vessels supply connective tissue, though in areolar tissue many vessels are present, passing to and from other structures. Lymphatic vessels are very numerous in most forms of connective tissue, especially subcutaneous, submucous and subserous areolar tissue, but it is doubtful whether any nerves end in areolar tissue."

The General Disposition of Fascia.

In the female pelvis, all these connective tissue elements are, of course present, but this review will be chiefly concerned with two of them - areolar tissue, subjacent to the pelvic peritoneum and surrounding parts of the viscera, and white fibrous tissue represented by the epimysia of the pelvic muscles - the deep fascia. This is a "tough inelastic membrane which forms a continuous layer throughout the body, covers the surfaces of the muscles, or may ensheath them, and often forms an important part of their attachments. It blends with all ligaments with which it comes in contact, and as it passes over bony surfaces, fuses with the periosteum. It may gain firm attachment to the skeleton, and materially assists muscular action by forming an unyielding membrane against which the muscles contract." (Smout and Jacoby, 1946)

However, it is important to realise that distinctions, both gross and histological, between the different types of tissue are not clear cut. Transitional forms of fibro-areolar tissue are common (Ricci et al. 1947). All these tissues develop in continuity from undifferentiated mesenchyme, and hence there are no sharp divisions between them. Fothergill (1908) quoting Keith, states/
states "It has been customary to regard fasciae as separate structures forming distinct sheets with devious and complex courses. It is possible by dissection to prepare and display them according to accepted descriptions, but the structures so displayed are artificial."

THE MUSCULATURE.

The distinction between striated voluntary, and plain involuntary muscle is more easily made, either on dissection or microscopic examination. However, the levator ani and the perineal muscles, and the plain muscle "tubes" of the pelvic visceras, come into an intimate relationship at the outlet of the female pelvis, and it is found that there are fundamentally differing descriptions of this anatomical relationship, as though the differentiation of these tissues was not easily made.

In addition, scattered plain muscle cells are found in the pelvic connective tissue. Many of these are derived from the outer muscle layers of the visceras, and others are said to develop from the muscle elements in the walls of the blood vessels.

BASIS OF DESCRIPTIONS.

1) Dissection.

Naturally the greater number of anatomical descriptions to be reviewed are based on dissections of the cadaver. The subjects include old and young women, infants, and foetuses. It is in these latter, at about the fifth or sixth month of development, that the disposition of the connective tissue can be most readily studied since, at this time, the pelvic fat, which masks the definition of the other structures, is not yet developed. But no great advantage has been taken of this fact in previous studies.

A misleading feature of dissection of the preserved cadaver is the effect of formalin on the connective tissue. It entirely destroys the elasticity of any tissue, and by hardening, gives a definition and importance to layers, which they do not possess in the living subject.

Other dissection studies have been made in the living at the time of operation, but again, some of the findings may be fallacious, since the tissues are often altered by injury, inflammation, or other disease, and may be distorted by their operative exposure.

2) Histological Study.

This has been of great value in defining the nature and origin of the different tissue elements, and the intimate relationship of plain muscle, voluntary muscle, and connective tissue in certain parts of the pelvis. Considerable use has been made of differential staining methods for this purpose. These investigations have shown up many erroneous conclusions drawn from earlier dissections. (Campbell. 1950., Goff. 1948., Ricci et al. 1947. 1950, Wesson. 1923., etc.)

3) Radiological Study.

By the use of radiopaque fluids and catheters, the hollow pelvic viscera can be delineated on an X-ray film or screen. In this way the normal anatomical relationship of the organs in different postures, and their descent or displacement in prolapse can be studied. The effects of voluntary muscle action can also be/
be demonstrated (Diddle et al. 1947., Kegel. 1950.) This method has been particularly fruitful in the study of normal and abnormal micturition and of the anatomy of the lower urinary tract during labour. (Millin and Read. 1948., Muellner. 1949., Malpas et al. 1949., Bell et al. 1950., Cohn et al. 1950.)

4) Embryology and Comparative Anatomy.

It is of tremendous help in describing and understanding the disposition and importance of these pelvic structures to trace their ontogenetic and phylogenetic development. Several of the more obscure or unexpected anatomical findings are explicable only in this way. The disposition of the connective tissue is moulded during the embryonic development of the genital and urinary tracts in the surrounding mesenchyme. The pelvic musculature is more fully understood by reference to the pelvic floot in pronograde animals and lower forms of life (Thompson. 1899., Bwer. 1948).

Embryological study is also of value in nomenclature, especially where the anatomy is different in the two sexes.

SCOPE. DEFINITIONS AND NOMENCLATURE.

It is not intended that this essay should be a complete consideration of every fascial and muscular structure and layer throughout the female pelvis, but rather a selective description, giving particular attention to those parts that have, or are thought to have, a function of supporting the genital organs, the bladder and the urethra.

I shall consider successively, then, descriptions of the superficial perineal muscles and their fascia, of the perineal body, of the intrinsic and extrinsic muscles of the urethra, of the levator ani muscle and of the pelvic fascia.

The approved nomenclature is that of the Birmingham Revision (1933) of the Basle Nomina Anatomica. However, many of the names of the old B.N.A. seem to have gained a permanent place in the literature through frequent usage, and in addition many new terms have been used, some descriptive, some eponymous, the latter particularly by surgeons. "Unfortunately", as Close (1947) states, descriptions left to the surgeon have often suffered through the ignoring or misplacing of the terms of ancient anatomical usage; the coining of new terms for previously recognised structures has become the vogue with gynaecologists, such terminology being usually influenced by technical surgical procedures rather than by the morphology of the tissues, or the adaptability of such terms to the homologous structures in the opposite sex."

Fortunately, the multiplication of names for new and old structures cannot continue indefinitely, and indeed, several more recent anatomical studies have been devoted more to disproving the existence of certain structures than to discovering or naming new ones. (Bissell. 1929., Kester. 1933., Cott. 1948., Ricci et al 1947. 1950.)

IMPORTANCE.

The importance of these tissues, as the title of the essay indicates, is their support of the pelvic viscera, and their role in the mechanism of micturition. They are therefore concerned in the aetiology of prolapse and of stress incontinence, and in the surgical correction or repair of these conditions. The fascial layers and connective tissue are also of great importance in the radical/
radical surgery of pelvic malignant disease, since these tissues are intimately related to the vascular supply and lymphatic drainage of the viscera. As Peham and Areich (1934) state, "The fascial and vascular systems of the pelvic organs constitute together an anatomic unit, and they present, in practice, such an intimate relationship that the one system cannot be considered independent of the other."

**SOURCES.**

The papers and texts on which I have drawn in this study represent a very cosmopolitan company of authors. In this country the anatomy of the pelvic tissues received particular study and interest at the beginning of this century, when a series of stimulating anatomical papers by Thompson (1901), Paterson (1907-8), Derry (1907-8), Cameron (1907-8) and Smith (1907-8) led up to an important anatomico-clinical paper by Fothergill (1908), Bonney (1923, 1934) and Shaw (1947) have later made contributions.

However, in the preceding century the subject had been written about extensively on the Continent by both German and French authorities (Halban, Kocks, Mackenrodt, Testut, Rieffel, Cuneo and Veau, Delbet). American contributions, often with histological confirmation, have come in more recent times from Curtis (1939, 1940, 1942), Kennedy (1946) and Campbell (1950). From Australasia, McGuire, Close and Pacey have written on the pelvic anatomy.

The structures and supports to be considered are, naturally, continuous, but though artificial, it is more convenient to describe them separately in different regions. As the connective tissue elements and the muscle in each region are in intimate relationship, they must be considered together.

**THE PERINEAL MEMBRANE (B.R.) THE UROGENITAL DIAPHRAGM (B.N.A.) OR TRIANGULAR LIGAMENT.**

The standard description of the perineal membrane in the female is that given by Cunningham (1945), who calls it a fibrous sheet or membrane stretching across the pubic arch. Its posterior border is fused with the posterior borders of the membranous layer of fascia that covers the upper surface of the sphincter urethrae and deep transversus perinei muscles. Its anterior border is thickened to form a band called the transverse perineal ligament - this border also being fused with the fascia that covers the sphincter urethrae. The space between the membrane and that fascia is therefore closed: it is called the deep perineal pouch. This authority gives no indication of the origin or nature of the perineal membrane, and does not appear to regard it as a part of the deep fascia, since it is stated "The deep fascia of the perineum exists only in the form of the delicate fasciae of the muscles."

Gray (1949) describes the membrane as essentially part of the deep fascia investing the sphincter urethrae and deep transversus perinei. He mentions its continuity with the pudendal neuro-vascular fascial sheath, and states, in disagreement with Cunningham, that it is continuous posteriorly with the anal fascia (on the inferior surface of levator ani).
The description of Smout and Jacoby (1948) is essentially the same as that of Cunningham. They state that the perineal membrane itself is a tough fibrous structure, but describe the superior layer of fascia above the muscles as thin and weak, and consider it merely a part of the pelvic fascia which bridges the gap between the levators ani. Cunningham however, as mentioned above, speaks of a definite vertical gap between the levator and the urogenital diaphragm - a "diverticulum" of the ischio-rectal fossa extending forwards right up to the pubis. Curtis et al. (1942) confirm this finding. These latter authors consider the urogenital diaphragm a quadrangular structure, and describe the fibres of the transversus perinei as sweeping backwards, deep to the external anal sphincter, to a firm coccygeal insertion.

Maguire (1950) has even further stressed the anatomic strength and surgical importance of the urogenital diaphragm. He describes the lower layer as "a strong dense felted membrane in the same morphological plane as the obturator membrane, . . . consisting largely of white fibrous connective tissue, and giving passive support to all the structures in the pelvis between the pubis and the tuber ischii."

All these descriptions, then, indicate that the perineal membrane is a layer of considerable anatomical density and importance, and most imply that it has a fibro-membranous character apart from the ordinary relationship of deep fascia and voluntary muscle.

However, the opposite view does not lack support and evidence. Wesson (1925) in a study of the anatomy of the perineum in the male, based on dissections and histological evidence in the foetus, stated "Probably because of the hardened fascia of embalmed bodies, there is a tendency for the dissector to consider the urogenital diaphragm as the keystone of the perineum, the other structures being formed secondarily, and to discredit all theories that do not presuppose the presence of a primary rigid double -walled triangular membrane . . . . This is largely an assumption which the embryological facts as shown in the preparation and study of the foetal pelvis to be described do not warrant, and the urogenital diaphragm is to be regarded as an after-development to the urethra, muscles, and other structures, and derived essentially from a condensation of loose mesenchymal tissue." Wesson concluded that this layer consisted merely of extensions of the parietal (i.e. muscular) fascia, and the visceral fascia, which forms the "capsule" of the visceral tubes, and the neuro-vascular sheaths. Cameron (2)(1907-8) too, in a comprehensive review of the pelvic fascia, draws attention to the composite character of the triangular ligament, and says that in the female it is broken up into its main constituents. "One portion forms the sheath of the compressor (sphincter) urethrae, and is also fused with the sheaths of the bulb and crura clitoridis, the latter carrying its attachment backwards on each side of the pubic arch. Posteriorly, there is a very scanty sheath around the deep transversus perinei, passing behind the vagina, but CONNECTED IN NO WAY with the sheath of compressor urethrae by a continuous membrane." Derry (2)(1907-3), and Smith (l)(1907-8) state that no deep layer of the triangular ligament exists, there being merely a forward continuation of the anal fascia. The latter writer contrasts the degree of development of the "ligament" in the female and in the male, where it has greater density and importance, forming a "point d'appui" during erection (Delbet).
There are, then, these two contrasting descriptions of the triangular ligament in the female, either as a primary stout ligamentous sheet, with certain muscle slips above or below it, or as consisting merely of the fascial investment of these muscles, if indeed it is worthy to be considered as a single entity. The latter concept I think is the correct one.

THE PERINEAL BODY (B.R.) OR CENTRAL POINT OF PERINEUM (B.N.A.)

THE RELATION OF VAGINA AND RECTUM. THE "RECTO-VAGINAL SEPTUM."

The superficial perineal muscles are derived from the primordial sphincter cloacae. (Thompson 1899, Power, 1948)

As the cloaca divides into a dorsal and a ventral portion, and the uro-rectal septum extends caudally, some fibres of the elliptical sphincter are found to decussate between the anus and the urogenital sinus. From this figure-of-eight muscle, the perineal muscles differentiate, and at the point of decussation the perineal body is formed. It is described (Smout and Jacoby, 1948) as a fibromuscular area lying in the midline between the vulva and the anal orifice, where several muscles converge - the transversus perinei, superficial and deep, the bulbocavernosus, the external anal sphincter, and the levator ani, the latter being much the most important constituent. Thus is formed a pyramidal wedge lying below and behind the lower third of the vagina. In addition, according to Cunningham (1943) and Gray (1949), it receives longitudinal involuntary muscle fibres from the wall of the rectal ampulla and the anal canal. Thus it tightly fuses the vaginal wall to the lowermost rectum and anus. (Ricci et al. 1947)

The bulbospongiosus, ischiocavernosus, and external anal sphincter muscles need not concern us further, since they are manifestly not visceral supports. The sphincter urethrae will be considered along with the other urethral musculature. The superficial transversus perinei is an inconstant, feebly developed muscle slip, and its deep partner is another small bundle, considered by Luschka to be an extension of the levator ani, and which only develops during post-natal life. (Wesson, 1923, Power, 1948.)

Apart, then, from the substantial contribution of the levator and muscle itself, as its fibres decussate between the vagina and anal canal, the perineal body has no strong supportive muscle elements, and Fothergill (1908) emphasised how frequently complete laceration of the perineum may be found without any failure of the genital supports.

Above the apex of the perineal body, the middle third of the posterior vaginal wall and the rectum lie in close relationship. Each viscus is closely invested by its own outer fibrous coat of connective tissue. "In each instance the fascial sheath is in intimate relationship with the musculature of the corresponding viscus, receiving muscle fibres from it." (Curtis et al. 1942)

However, there is disagreement between various descriptions of this area, as to whether there exists any intervening layer or septum and if so, as to its nature and origin.

In 1836, Denonvilliers first described in the male a coronal layer of fascia lying between the prostate and the rectum, which has since borne his name. Cunco and Vezu (1899), in a further study of this layer, again in the male, concluded that it was a peritoneal derivative, formed by apposition and fusion of the anterior and posterior walls of the rectovesical pouch of peritoneum as the depths of the pouch become obliterated and the level of the pouch rose, during intra-uterine development. The presence of
this layer in the female was confirmed by Smith (2)(1907-8) who described "the aponeurosis of Denovilliers passing behind the vagina to the perineal body." A more complete description is that of Snout and Jacoby. (1948). "The lower extremity of the recto-vaginal pouch is attached to the central point of the perineum by the recto-vaginal septum, which is a thickened strand of extra-peritoneal connective tissue; and since developmentally it is formed by the fusion of two layers of peritoneum, resulting in the obliteration of the caudal end of the pouch, it is comparable to the fascia of Denovilliers in the male."

In Cunningham's textbook (1943) there are several references to the rectovesical septum in the male, but no mention of a recto-vaginal septum, and indeed, the authors state (p. 622) "In the female the rectum, below the peritoneal reflexion, is in direct contact with the posterior vaginal wall, to which it is loosely attached above, but more closely below." Jamieson (1947) also, does not mention this structure in the female. Close (1947) acknowledges the presence of this septum in the female, and affirms its peritoneal origin, and Kirk (1947) also appears to consider it a peritoneal derivative.

However, Wesson (1923) in a study including histological sections from male foetuses, contends firmly that the layer is not of peritoneal origin. "It is a generally accepted embryologic law that when two layers of peritoneum are permanently approximated, the constituents revert to type, and the mesothelium is absorbed and disappears, leaving only a bed of undifferentiated mesenchyme."

Moreover, the actual existence of any septal layer between the vagina and the rectum has been denied. Koster (1933) in a histological study of a single cadaver, and many operation specimens, could find no fascia in the recto-vaginal septum. Peham and Amreich (1934) do not mention the subject in their description of the pelvic fascia. Curtis et al. (1940) in a dissection study, could not find this layer. Ricci et al. (1947) in an extensive histological examination of the perivaginal tissues, conclude that there is a cleavage plane, an areolar zone, between the vaginal wall and the rectal wall from approximately the ano-rectal junction to the level of the cul-de-sac. There are present loose shreds of areolar fibres, but no tissue layer. Goff (1931) reached a similar conclusion.

The whole question of the existence and nature of the recto-genital septum has recently been reviewed by Uhlenhuth et al. (1948). Their conclusions are that with few exceptions the recto-genital septum can be clearly demonstrated (on dissection of the cadaver) in adults of both sexes, but that in some subjects it is missing, or perforated, or consists only of strips. "This variability in completeness explains some of the differences of description found in the literature, as well as the failure of some authors to find such a septum." Also, they state that the layer is closely adherent to the vaginal capsule in females, which again would hinder any attempt to demonstrate its presence. On the basis of measurements made at various stages of human development, and demonstrating the recession of the level of the peritoneal pouch, they conclude that the layer is a peritoneal derivative.

Whatever the origin of this "septum" may be, no description of it in the female makes it out to be more than an irregular, tenuous, or deficient membrane, which can obviously not be credited with any supportive value, either in fixing the perineal body to the recto-vaginal peritoneal pouch, or in restraining forward herniation of the rectum.
THE TISSUES ABOUT THE URETHRA AND THE BLADDER NECK.

THE EXTRINSIC AND INTRINSIC MUSCULATURE OF THE URETHRA.

The female urethra is a narrow short muscular tube, in the walls of which both plain and striated muscle elements are present. By a funnel like expansion, it is continuous above with the bladder neck, and it terminates at the external meatus, passing almost at a right angle through the planes of the levator ani muscle, and of the muscles of the urogenital triangle.

In the female, the whole urethra is derived from the vesico-urethral portion of the cloaca. It is not therefore strictly comparable with the whole male urethra, but is homologous with that part of the prostatic urethra which lies headwards of the orifices of the prostatic utricle and the ejaculatory ducts. (Gray. 1946) This fact is often overlooked in making comparisons between the sexes.

The urethra and the bladder trigone have a close anatomical relationship to the anterior vaginal wall, the precise nature of which has been, and still is, the subject of controversy. Also, the relationship of the urethra to the muscle planes which it "pierces" is not an agreed subject. Further, the disposition of the intrinsic musculature of the urethral wall has been variously described. These, then, are the anatomical points we shall consider in more detail.

THE RELATION OF THE VAGINA TO THE LOWER URINARY TRACT.

This subject has recently been subjected to most thorough microscopic study by Ricci et al. (1947). Their material consisted of twenty two specimens of the pelvic viscera removed en bloc. Four of these were from foetuses, three from infants, and the remainder from adults. Serial histological sections were cut in different planes through the parts to be described. Some were stained with differential stains to demonstrate the elastic and fibrous tissue elements.

After presenting a description of each specimen, they conclude as follows.

The vaginal wall is a fibro-elastic muscular structure with abundant connective tissue fibres. The muscle layers are not separated into two distinct layers of outer longitudinal and inner circular, but the longitudinal and circular fibres are of irregular distribution. They do not form distinct muscle coats.

There is complete fusion of vaginal and juxtaposed urethral wall throughout the entire length from the external meatus to the base of the trigone. The walls are completely integrated into one solid structure by interweaving connective tissue and elastica. The fusion is so intimate that it is difficult to distinguish the muscular component of the vagina from that of the urethra. Between the vagina and the urethra, there is neither cleavage plane, areolar zone, nor any substance remotely resembling a sheet-like structure of compact connective tissue, i.e. a fascia. There is a cleavage plane of loose shreds of areolar fibres between the bladder, from the utero-vesical fold to the trigone, and the vagina, but no fascia. Such designations as urethro-vaginal, vesico-vaginal, pubo-cervical, and utero-pubic fascias are gynaecological misconceptions.

Goff (1931) in an earlier histological study of the peri-vaginal fascia in a previously healthy nullipara aged twenty seven, reached the same conclusions. He stated that there is no tissue in the/
the walls of the vagina, urethra or bladder which can logically be called fascia, if the classical histological descriptions of the tissues are observed. The muscle coats of the urethra and vagina are fused, and there is no fascia between them. There is a thin layer of areolar fascia between the anterior vaginal wall and the bladder wall. The same author confirmed these findings in a later paper. (1948).

Bissell (1929) made a microscopic study of twenty-five specimens of tissue removed from the anterior vaginal wall during operations for prolapse, and found that there was no fascia present. He demonstrated that the "fascia" often dissected off the vaginal wall and used for repair is muscular tissue—part of the vaginal wall. Koster (1933), also, in another histological study of sections from the cadaver of a multipara, aged thirty-one, found no well-formed fascia in the vesico-vaginal septum.

These authors, then, are unanimous in stating that there is no fascia between the lower genital and urinary tracts. The only connective tissue elements present, apart from loose areolar shreds, are the thin fibrous coats of the viscera themselves, (Goff. 1931), which are intimately fused with their underlying musculature (Curtis et al. 1942). This conclusion receives further indirect support from the recent radiological studies of Malpes et al. (1949) and Cohn and Weinburg (1950) which showed during labour no fixed attachment between the bladder and the cervix.

Other writers, notably gynaecological surgeons, have put forward quite different descriptions of the layers between these organs. Bonney (1923) described a sheet of "pubo-cervical" fascia lying behind the urethra and bladder, and slinging these organs from the pelvic wall. He stated that this layer gained a firm attachment to the cervix also, and ascribed to it considerable importance as a visceral support. Elsewhere in the same article he calls this layer a "muscle sheet." Its situation is illustrated by drawings, but there is no direct histological confirmation of its presence. The term pubo-cervical fascia, however, has come into widespread use, and reference to this layer, and its importance, is found in many recent gynaecological textbooks.

Sears (1933), whose study was based on the dissection of four female pelvises, also described a prevaginal fascial layer, and claimed that since this layer was reflected from, and continuous laterally with the superior levator fascia, it proved that a true "fascia" surrounded the vagina. This point will be taken up later, under the description of the pelvic cellular tissue.

A very detailed description of the anterior vaginal wall, particularly in its lower part, has been presented by Shaw (1947). He also describes a transverse supporting sheet of tissue behind the urethra and bladder neck, bounded by a well defined upper margin, a little more than three centimetres above the external urinary meatus. "All gynaecologists must have recognised the condensation of fascia round the urethra, and the term paraurethral fascia is sometimes used. In view of its condensed consistence, of the lateral attachments, and of the well-defined upper border, in my view it should receive separate terminology, and I have suggested the term post-urethral ligament. The ligament extends from an attachment to the pubic ramus on one side, below and behind the urethra and neck of the bladder to the pubic ramus of the opposite side... It consists mainly of plain muscle tissue." Nevertheless, Shaw illustrates this layer as being formed by the fusion of the fascial capsules of the vagina and bladder.

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The notion of such a layer is, of course, a direct contradiction of the histological studies of Goff (1931) and Ricci et al. (1947) and it might be thought that Shaw was thus interpreting the firm fusion of the vaginal and urethral muscle walls, were it not that he also describes a loose space behind the ligament "between the fused fascias and the skin of the vagina with its thin layer of vaginal fascia." This space is filled with "loose connective tissue, which must be cut through with the sharp end of a scalpel." (4)

Although the post-urethral ligament may be a concept of much value in gynaecological surgery, its existence lacks any histological confirmation to date. McGuire (1950) considers that it consists merely of the margin of the triangular ligament, through which the vagina and urethra are said to pass. But the microscopic evidence all agrees that vaginal and urethral muscle walls are tightly fused, without any intervening layer. Further, Ricci and his colleagues (1950), in the paper to be quoted in more detail below, state firmly that there are no fascial sheaths (fascia diaphragmatic urogenitalis inferior and superior) and no compartments (superficial and deep perineal) pierced by the urethra.

In the consideration of the uro-vaginal septum in the female, we are also concerned with the relationship of the levator ani and the external sphincter urethral muscles to the urethra, but these two points will be taken up when the muscles themselves are described.

THE INTRINSIC MUSCULATURE OF THE URETHRA. THE "MUSCLE OF MICTURITION."

A most comprehensive histological study of the female urethra has recently been presented by Ricci and his colleagues (1950). Their material consisted of twenty one urethras, with the surrounding soft parts, right out to the peristeum of the pubis. The specimens were from foetuses, the newborn, infants and adults, and the architectural pattern was found to be constant from the earliest foetus (4 months) to the oldest woman (77). Blocks were cut in different planes, and stained with haematoxylin and eosin, and also with connective tissue, elastic tissue and nerve stains. Their description, in summary, is as follows.

The urethral wall consists of three layers - 1) stratified squamous epithelium, throughout its whole length. 2) A substantia propria (sub-epithelial connective tissue layers) throughout the whole length. In the upper and middle thirds it is composed of fibrous connective tissue, rich in fine elastic fibres and moderately rich in blood vessels. In the lower third the substantia propria becomes extremely thick, and is a mass of fibrous tissue. 3) The muscle layer. The upper third is a continuation of the bladder muscle. At the level of the internal urethral orifice the middle circular layer of the bladder wall becomes extremely prominent, and completely encircles the lower portion of the bladder and the upper portion of the urethra. On the anterior wall the muscle is extremely prominent, (c.f. Kennedy (1946) and Curtis et al. (1942) below) but posteriorly it becomes lost in the fibro-muscular trigone and the urethro-vaginal wall. It is over lapped by the thin outer longitudinal muscle, which is not always present. The posterior wall is a compact structure, and is a continuation of the fibro-muscular trigone, in which the anterior circular involuntary muscle fuses. (This is to be compared with Kennedy's description of the "insertion" of the muscle of micturition - though this latter is said to consist of striated muscle.)
The middle third is made up of an outer striped muscle bundle which is circular, and surrounds this portion of the urethral lumen, and also an inner layer of fine plain (involuntary) muscle fibres. The striated muscle is thicker in the centre, tapering off at the ends (i.e. fusiform).

The lower third of the urethral wall is composed of fibrous tissue, and is free of muscle of any sort. There is no intrinsic external voluntary muscle sphincter, nor a sphincter of the membranous urethra.

This description by Ricci, in view of the extensive histological study on which it is based, and the identity of the findings in all the specimens examined, must be considered authoritative. Nevertheless, a quite different description of the urethral musculature was proposed by Kennedy (1946). His material consisted of one adult urethra, and three specimens from full term female infants. The microscopic sections were stained von Gieson. Kennedy describes the true urethral sphincter, wholly composed of circular plain muscle, as surrounding the inner and middle thirds of the urethra. But the most notable part of his paper is a description of the "muscle of micturition." This is stated to be a voluntary muscle sphincter around the upper part of the urethra. It is described as follows.

"Studying these slides, one gets the following picture of the striated muscle. Two origins can be seen, each loosely attached to the periosteum of the anterior medial face of the ramus of the pubis, about the level of the superior part of the perimeter of the urethra, in the plane of the rami. (This is rather obscure.) The muscles from these origins pass over the urethra transversely, and as they pass laterally they enter the wall of the urethra to pass obliquely and posteriorly as a purse-string between the circular and longitudinal muscles, and when they reach the inferior wall of the inner third of the urethra, the greater number of fibres pass transversely. Two small bundles jut out posteriorly from these transverse fibres and find their way into and among the longitudinal muscles of the trigone, and end there. These two muscle ends are the insertions."

Despite the keen interest which Kennedy's paper aroused, and the ingenuity of his physiological propositions, his description of the muscle of micturition has not been independently confirmed, and it cannot be said that the photomicrographs which illustrate the article would convince a sceptic, though this may merely be a technical failure of reproduction. The only hint of agreement comes from Curtis et al. (1942) who, describing a dissection of the pubococygeus muscle, state "the anterior fibres which cross transversely in front of the urethra are muscular, and form a narrow but strong band." This may be what Kennedy calls the origin of the muscle of micturition.

These two studies of the urethral musculature are in obvious disagreement, and do not even afford a basis for a compromise description. It is evidently a matter which would repay further study. The majority of standard anatomical texts deal briefly with the subject. Cunningham (1943) states that striated muscle fibres are present in the outer surface of the muscle coat of the urethra. In the upper part of the canal these fibres from a complete ringlike sphincter, but in the middle and lower thirds the striated fibres are present only in the front walls, passing backwards on to the outer surface of the vagina. It is interesting to compare this/
this description with the observation made by Kegel (1950), when studying his perineometer in the vagina, by means of X-rays. Kegel noted that during voluntary contraction of the pelvic outlet muscles, a "constriction rug" was visible in the vaginal wall, and that this involved the anterior wall also.

In passing, other radiological studies of the bladder neck and urethra must be mentioned here. (Millin and Read (1948). Mueller (1949). Ball et al. (1950). Although these papers have elucidated the normal position, movements, and displacements of the urethra and bladder neck, they have not provided any anatomical basis for the findings.

THE EXTERNAL URETHRAL SPHINCTER.

This muscle, according to the leading anatomical texts, is a thin slip lying in the anterior part of the deep perineal pouch, and embracing the lower part of the urethra. Cunningham (1943) states that the fibres arise from the inferior pubic rami, and are directed medially to enclose the urethra, but, together with the deep transversus perinei, are also attached to the side of the vagina. According to Smout and Jacoby (1948) the origin of the external voluntary fibres extends backwards on to the ischiial rami also. They further describe internal involuntary circular fibres which surround the membranous urethra. Hooper (1949) also differentiates internal and external fibres. The external fibres arise on either side from the transverse perineal ligaments, and sweep backwards on each side of the urethra. Some of the fibres interlace with those of the opposite side between the urethra and the vagina, while others can be traced on to the vaginal walls. The inner fibres encircle the lower end of the urethra. The description by Curtis et al. (1939) of the dissection of this region names the pubo-urethral ligaments, a local elevation of the fibres of the urogenital diaphragm, forming two musculo-fascial wings around the urethra. "The voluntary muscle fibres," they state, "become lost among the intrinsic musculature of the urethral wall. Between the urethra and the vagina only a slight interval exists, through which a few fibres of the sphincter interdigitate with those from the opposite side of the perineum, but the bulk of the muscle fibres of the so-called sphincter urethrae actually terminate in the wall of the vagina ....... The urethra, then, receives considerable muscular support; on the perineal aspect sphincter fibres pass into and in front of the urethra, downwards upon it, and behind it. The latter bend is available for surgical connection of urethrocele." (c.f. Shaw (1947) and McGuire (1950) quoted above.)

It is obvious that the above descriptions of the so-called external urethral sphincter differ materially one from another. It is noteworthy also that they are all based on anatomical dissections, and that they are absolutely contradicted by the histological study of Ricci et al. (1950) who concluded that there was no interval between the fused urethral and vaginal walls, through which external sphincter fibres might pass, that in any case no intrinsic external voluntary muscle sphincter exists nor a sphincter of the membranous urethra, and that the lower third of the urethra is composed of fibrous tissue, and is free of muscle of any sort. Certainly it is beyond controversy that the lower half of the urethra may be surgically removed without any way impairing urinary control.
THE LEVATOR ANI MUSCLE.

Phylogeny and ontogeny.

"The levator ani muscle is an evolutionary product representing the caudal flexor, abductor musculature of tailed mammals, which in man, as in anthropoid apes, with the reduction of the tail, has gained new relationships with the pelvic viscera. The coccygeus represents the proximal ventral caudal abductor of tailed mammals." This quotation is taken from a paper by Power (1948) but such a concept of the levator muscle was expounded many years earlier by Thompson (1899). The muscle, however, is considerably less developed in man than in the tailed animal. It is a mere adumbration of the masses of contractile tissue which subserve the locomotion of the prehensile ape and the tripod kangaroo. (Fothergill. 1908)

Thompson (1901), further comparing the muscle's origin in man and in pronograde animals, suggested that in man also the muscle might be considered to have an attachment along the line of the pelvic brim, and that the obturator fascia represented the aponeurosis of origin of the ilio-coccygeus from the upper part of the pelvic wall. Smith (1)(1907-8) agreed with this view, stating that it would be correct to say that the pelvic cavity is lined by the aponeurosis of the levator muscle, which is subject to great variations in thickness and texture in different subjects, and in its various parts in the same subject. The white line of the levator ani is the tendinous attachment of the ilio-coccygeus to the pubis and the ischial spine.

This concept of the origin of the levator muscle has gained general acceptance. Fothergill (1908). Close (1947). Cunningham (1943).

Power (1948) has recently propounded new views on the embryogenesis of the levator ani. These may be summarised as follows. The skeletal musculature is derived almost entirely from the primitive myotomes, the muscular segments of the dorsal devisions of the trunk mesoderm. As the body wall develops, extensions of the myotomes migrate ventrally into the walls, and the ventral ends of these extensions fuse together to form a ventral longitudinal muscle column, from which the rectus abdominis and pyramidalis, and the hyoid depressor muscles develop. Now in early human development the cloacal membrane lies on the caudal edge of the umbilical cord, and at a later stage it migrates caudally into the perineum. The levator ani muscle is derived from the fourth sacral myotome, and it is suggested that this, as it migrates ventrally, becomes divided like the myotomes of the abdominal wall into two portions; a laterad part, the ilio-coccygeus, corresponding roughly to the oblique abdominal wall muscles, and a ventral longitudinal column, the pubococcygeus, to be compared with the rectus abdominis. The longitudinal muscle column of each side, therefore, extends morphologically between the two openings of the alimentary tract, but is interrupted at two places — by the formation of the sternum and of the os pubis. In other words, as the cloacal membrane migrates from the umbilical cord to the perineum, it carries with it, so to speak, an extension of the linea alba, and also an extension of the tendency of the myotomes to form a longitudinal muscle column on each side of the linea.
Power illustrates this view by describing the dissection of a case of ectopic vesicae, in which the rectus abdominis passed without a break into the pubo-rectalis. He also puts forward comparisons with the pelvic muscles in selachians and amphibians, in support of his argument. While Power's views may not command complete general acceptance, they certainly provide an embryological explanation for the contrast between the stout fleshy pubococcygeus and the thin, flattened, and partially membranous iliococcygeus.

The course and disposition of the levator ani muscle fibres.

The origin of the muscle, at least, does not seem to be a subject of disagreement. It arises from the pelvic surface of the pubic bone, from the pelvic surface of the ischial spine, and between these, from the arcus tendineus of the muscle. This fibrous crescent, the "white line", marks laterally the junction between the fleshy part of the iliococcygeus and its fascial aponeurosis, extending upwards to be attached along the arcuate line at the pelvic brim, while anteriorly the arcus tendineus crosses the pelvic surface of the pubic origin of the levator, and itself gains attachment to the bone near the midline. (Cunningham, 1943)

From this origin the muscle fibres pass backwards, inwards, and downwards. We have already discussed the contrast in thickness and strength between the pubococcygeus and iliococcygeus parts of the muscle. The iliococcygeus is thin, degenerate, transparent, (Fothergill, 1908) a thin sheet in which the muscle fibres are feebly developed and often separated by membranous intervals (Cunningham, 1943). Cunningham also describes separately the puborectalis fibres, which take origin from the pubis lateral to the pubococcygeus, and, crossing medially, interdigitate behind the rectum.

In most anatomical texts the insertion of the levator is stated to be into the perineal body, the side of the anal canal, the anococcygeal body, and the lower pieces of the coccyx. (Jamieson, 1947) However, several writers have claimed that the muscle is also inserted into the walls of the urethra and vagina, and that the fibres interdigitate between these organs, forming supporting slings. Since this point is of some importance in assessing the visceral supports, we shall have to consider the evidence for and against it.

Smout and Jacoby (1948) state that the most medial fibres of the levator skirt the urethra, blending with its intrinsic muscular coat. They then form a loop around the vagina and are inserted into its lateral and posterior walls, and into the perineal body. They do not state their authority for this description. Curtis et al. (1939, 1942.) on the basis of several careful dissections of the cadaver, also describe the insertion of the muscle into urethra, vagina and rectum. "The visceral sets of fibres turn quite directly toward each organ, gaining implantation into their walls, and also join fibres between the viscera. The fibres which pass to the vagina ascend for a short distance upon the vagina, then lose themselves in the intrinsic musculature of the organ. There is no hiatus of the levator ani." Curtis also describes some fibres of the levator crossing anteriorly in front of the urethra, as mentioned above.

Kennedy (1946) from the histological study of four specimens, states that the levator passes its insertion into the lateral wall of the urethra near the junction of the middle and inner thirds of the urethra. Pacey (1949) also, emphasising the role/
role of the levator muscle as the paramount visceral support, suggests that the muscle has an insertion into and between all the visceral tubes. But, with great honesty, he pose and answers this question. "Has the operating gynaecologist ever demonstrated this anterior fusion (between urethra and vagina) in the nullipara? Has he not, but for the purpose of this article it will be considered that the pubococcygeus is inserted in the midline into the urethra, vagina, and rectum, and between and behind each of these organs." On this rather arbitrary conclusion Pacey bases his argument on the importance of the levator as a support, and on its use in the surgical correction of prolapse. Precisely the opposite conclusion was reached by Fothergill (1908) who dismissed the importance of the levator muscle as a direct support, adding "even in virgins careful examination shows that the cervix uteri does not rest on the pelvic diaphragm, any more than the bottom of a hansom cab rests on the ground!"

Certainly the weight of the evidence, much of it histological evidence, is that the pubococcygeus has no insertion into the urethra and vagina, or between them. Goff (1931) made a histological study of the perivaginal fascia in a nullipara, and describes an areolar fascia between the lateral vaginal wall and the levator muscle. He emphasises that this tissue is part of the pelvic cellular tissue (fascia endopelvina) and that although it is laterally in contact with, and loosely attached to the muscle fascia which covers the superior surface of the levator ani, it is not a part of it. He quotes Halban in support of this statement. Nor does Goff describe any fibres of the levator in the uro-vaginal septum, and Ricci et al. (1947, 1950) confirmed this as described above. The urethral and vaginal walls are tightly fused together. Cunningham (1945) describes the fibres of the pubococcygeus sweeping backwards in contact with the side of the vagina, and Jamieson (1947) agrees they have no direct insertion into it. This is also the view of McGuire (1950) - "The anterior part of the levator does not come into relation to or contact with the urethra, nor are its fibres inserted into the vagina." The evidence and authority which accompanies these latter descriptions compels their acceptance as correct. However, it is interesting to note that Bell et al. (1950) have demonstrated radiologically that a continent woman, in the standing position, is able voluntarily to elevate the bladder neck, by attempting to "hold" urine, and it is difficult to conceive how this is accomplished, if the levator is not responsible.

The fascia (epimysium) of the levator ani.

The thin epimysium of the lower surface of the muscle is termed the anal fascia, a name which Blair Bell (1934) with much justification has deplored, considering it meaningless. We have already discussed whether this fascia is directly continuous anteriorly with the perineal membrane.

The fascia covering the superior surface of the levator has been given a variety of names. The nomenclature is bound up with the question of the relation of this layer to the connective tissue above it, to the viscera, and to the formation of "ligaments", a subject to be considered below.

THE PELVIC FASCIA.

"Having served as the inspiration for many controversial monographs by British anatomists and surgeons at the beginning of the century, very little of which material has appeared in the classical textbooks, the pelvic fascia as a field of interest would seem to have been abandoned latterly by the anatomist to the surgeon.
The former now mainly refers contemptuously to so much "packing" between and around the viscera, or to "a subperitoneal condensation of undifferentiated mesoderm", whereas the latter still know full well the value of certain highly differentiated condensations." (Close, 1847)

That the above quotation contains more than a grain of truth is suggested by another quotation from Jamieson (1947). "Students are expressly advised not to burden the memory with any detailed account of the pelvic fascia; even if they can understand it" - and this from a text whose pages provide scant comfort for the burdened memory! I shall endeavour now to discuss and bring together the contrasting viewpoints revealed in these two quotations.

The Muscle Fascia and the Cellular Tissue.

Under the heading Pelvic Fascia will be considered both the fascia of the pelvic muscles (B.R.) - also called the peristal endopelvic fascia (Smout and Jacoby. Uhlenhuth), the voluntary muscle fascia, (Halban) - and the pelvic cellular tissue (Peham and Amreich) also called the visceral pelvic fascia (B.R.) the pelvic connective tissue (Smout and Jacoby), the fascia endopelvina (Halban), the visceral endopelvic fascia (Uhlenhuth).

James Douglas, in 1730, gave the first clear description of the subperitoneal cellular tissue as a separate entity. Anderson and Makins (1909) presented a more complete description of this tissue, stressing its unity with the subpleural layer of cellular tissue. "A good deal of confusion exists concerning the pelvic fascia and the pelvic connective tissue. No one confuses the fascia transversalis with the extra peritoneal connective tissue, yet when identical structures are continued into the pelvis, they appear in the minds of some to lose their identity." (Smout and Jacoby. 1948) The same comparison with the layers of the anterior abdominal wall was drawn by Davies (1932) and Blair Bell (1934).

This latter writer also compared the two connective tissue elements with hard and cancellous bone. Some of the confusion referred to above springs from loose use of the term "fascia". Many authors have used this word to describe the connective tissue capsules of the pelvic viscera, and other parts of the pelvic cellular tissue. This has been roundly condemned, (Paterson. 1907-8. Derry (1). 1907-8. Cameron (1). 1907-8.) these writers vigorously maintaining that the term visceral pelvic fascia should be abandoned, since a fascia is always related to the surface of a voluntary muscle. Goff (1931), Davies (1932) and Blair Bell (1934) concur. In understanding and classifying the pelvic visceral supports it may be important academically to distinguish between these two connective tissue elements, muscle fascia and cellular tissue. But it must be emphasised that there is no anatomical dividing plane between them, since they are both mesenchymal in origin. It is not the case that the one is "attached" to the other in certain parts, but they have from the beginning developed as a continuum. The epimysium of the pelvic muscles is a mesenchymal condensation on the muscle surface, and the capsules of the viscera are a similar condensation of the same tissue on their surfaces.

The Ligaments: their origin and nature.

There have been described certain "ligaments", developed or differentiated from either the pelvic cellular tissue, or the muscle fascia, or both, and a major role has been claimed for them as visceral supports. A few authors have denied that such a differentiation is either correct or practicable. "Any attempt to/
to give definiteness to such layers is not only artificial but makes the description unnecessarily complicated, for the layers pass gradually into the general mass of subperitoneal tissue, and are no longer traceable." (Derry. (1)(1907-8) "It is unnecessary and morphologically incorrect to attach definite names to those parts of the spongiform arrangement which are more compact, as they necessarily must be, in one place than another; so in reality there are no such structures as Mackenrodt's ligaments." (Blair Bell.1934)

However, the great majority of authorities do consider that there are parts of the connective tissue worthy of separate recognition and description, and among them there appear to be two general concepts of the nature and origin of these more condensed portions.

The first view is that there is a specialised development of ligaments and sheets (tela) of connective tissue, partially or completely independent of the vascular anatomy. They are formed from cellular tissue, or muscle fascia, or both, in response to physical stress (the weight of the viscera) or with some teleological explanation. Smout and Jacoby (1949) propound this point of view as follows. "All the so-called ligaments are primarily thickened bands in the pelvic fascia which covers the musculature of the pelvic floor, but they are reinforced by voluntary muscle fibres from the underlying levator ani, and by the thickened bands in the overlying pelvic cellular tissue, in which are strands of involuntary muscle fibres derived from the adjacent viscera, especially the uterus . . . . . . As the reproductive organs grow, and so increase in weight, certain parts of the connective tissue are pulled upon and thus hypertrophy, and in this way bands are formed, which, with the subjacent fascia, form the so-called ligaments previously referred to. These ligaments should not be called perivascular sheaths, for the blood vessels lie in the connective tissue above the ligaments. As Bonney (1934) says "the description of them as perivascular sheaths is quite 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 label them have not really seen them."

The descriptions of the ligaments given in the majority of gynaecological textbooks are in accord with Smout and Jacoby's explanation of their origin and formation.

The other view is that the disposition of the cellular tissue is entirely linked with the anatomy of the blood vessels, it being relatively condensed about them, and also about the ureter and the surfaces of the viscera, as obtains throughout the rest of the body, and that no primary ligaments exist. Thus Cameron (1&2) (1907-5) writes "The branches of the anterior division of the internal iliac vessels are bound together by dense connective tissue, the perivascular sheath, and in this way a fascial mesentery is formed, which becomes denser and stronger as it is traced downward to the pelvic floor. These perivascular sheaths are the visceral supports." Fothergill (1908) is of the same opinion, adding "the viscera are therefore simply invested by the remains, in this mesenchymatous form, of the tissue in which they were originally developed, and the same applies to the vessels which supply them." Davies (1932) similarly speaks of the "vascular mesenteryoid" to the Mullerian duct forming its lateral support. Pehan and Amreich (1934) call the firmer, more condensed caudal parts of the cellular tissue the "ground bundle", and state that though it was formerly considered as a fixation structure of the pelvic viscera, it now appears to serve merely in the capacity of an accessory vascular mechanism - a support for the pelvic venous plexuses which it encloses and ensheaths.

It/
It will be seen that the greater number of authors referred to below have adopted this latter concept of the visceral supports, and the weight of their evidence indicates that it is the correct one.

The named ligaments.

1) The transverse cervical ligaments. (Cardinal or Mackenrodt's ligaments). This structure, so generally linked with the name of Mackenrodt, was described by Santorini in the thirteenth century, and by Vesalius in the fifteenth century, as well as by others. In 1880, fifteen years before Mackenrodt's paper, Kocks described it, and called it the cardinal ligament of the uterus. Mackenrodt himself gave it the name ligamentum transversum colli. It is the same structure as the frontal portion of the connective tissue ground bundle described by Peham and Amreich (1934) as the hypogastric root, or sheath, of Uhlenhuth et al. (1948), and the vascular compartment of Curtis et al. (1942).

Ovenden (1907-8) reviewed and criticised Mackenrodt's description, herself presenting a study of the structure, based on dissections and microscopic sections. She stated that the lateral origin of the ligament was not from the fascia pelvis, but from the connective tissue around the internal iliac and uterine vessels. This structure commences as a thick fibro-fatty mass covering the greater sciatic foramen and the piriformis muscle, where it serves as a broad sheath for the hypogastric and related visceral vessels and nerve plexuses. (Close, 1947) Its anterior limit is the dorsal border of the superior ischial ramus, ending at the ischial spine. (Uhlenhuth et al. 1949) The visceral vessels then run vertically downwards through most of their course, not transversely, (Fothergill, 1908) and the connective tissue sheath which surrounds them is integrated with the fascia of the lateral pelvic wall down to below the level of the ischial spine. It contains all the veins of the urogenital tracts. (Peham and Amreich, 1934) Curtis et al. (1940) also speaks of it as the "vascular compartment". In the tissue around the vessels are numbers of plain muscle fibres. (Ovenden. 1907-8, Sears (2) 1933, Power, 1939, Curtis et al. 1940, Cunningham. 1943., Close, 1947.) The cellular tissue itself is most condensed about the veins. (Curtis et al. 1940, Peham and Amreich, 1934) The Mackenrodt ligament is, then, a neuro-vascular bundle. (Cameron 1907-8, Fothergill. 1908, Davis 1932, etc.)

Since the bulk of these vessels and nerves run to and from the uterus and vagina, the "ligament" has an "insertion" into these organs. As the vessels approach the surfaces of the vagina and cervix, the connective tissue surrounding the vessels is continuous with the fibrous capsules of the viscera. (Cameron (1) 1907-8) Mackenrodt stated that the major central attachment was to the supravaginal cervix, but Ovenden (1907-8) showed that this was not so, but that more than half the attachment is to the lateral fornix and vaginal vault. Curtis et al. (1940) and McGuire (1950) agreed, and Koster (1933) demonstrated histologically the absence of any ligamentous insertion into the supravaginal cervix. This fact was further confirmed by Mengert (1956) who showed in the cadaver the greater importance of the paravaginal tissue, and by Fothergill (1908) who referred to the same fact in the living (during vaginal hysterectomy), and by Bonney (1947)(during radical hysterectomy). Davies (1932) also emphasised the importance of the paravaginal tissues, calling them the broad ligament of the vagina. Paterson (1907-8) gave this tissue the name "suspensory ligament of the vagina and urethra", and stressed its extreme vascularity.

It/
It will be evident that the name transverse cervical ligaments is anything but appropriate, since the structures indicated are not true ligaments, are not transverse, and not attached primarily to the cervix.

As the neurovascular bundle descends towards the pelvic floor, its vessels ramify and diverge as they approach the viscera. At the same time, the lateral space between the viscera and the pelvic wall is narrowed, because of the "funnel" slope of the levator ani. Hence, the density and homogeneity of the cellular tissue in the lower part of the pelvis is increased. It was to this part of the connective tissue that Virchow gave the name parametrium, stressing the abundant blood vessels and lymphatics that it contained. It was called by Peham and Amreich (1934) the horizontal portion of the ground bundle. Curtis et al. (1940) consider that the term parametrium is clinical rather than anatomical, since there is no line of histological demarcation between parametric, paravesical, and pararectal tissues. The horizontal division also, between the more loose connective tissue above, and the firmer denser caudal portion is by no means sharp, and there is no definite plane between them. (Peham and Amreich. 1934.) The demarcation is more obvious laterally, on the fascial surface of the levator, where there is a definite "white line" in the fascia - the tendinous arch of the pelvic fascia, on a level caudal to the tendinous arch of the levator ani. (Thompson. 1901., Close. 1947., Gray. 1948.)

However, various portions of this condensed vascular tissue, and of the superior fascia of the levator with which it is continuous, have been given separate names. Anteriorly, the fascia covering the rounded medial edge of the pubococcygeus is named the medial pubo vesical ligament. The levator fascia immediately behind and lateral to this, together with the vascular connective tissue upon it, medial to the tendinous arch of the pelvic fascia, constitutes the lateral pubo vesical ligament, or true lateral ligament of the bladder. (Close. 1947., Gray. 1948.). Uhlenhuth et al. (1948.) state that these structures are not composed in part of the perivas cular connective tissue, but are part of the "fascia endopelvina - a horizontal sheet of the nature of a true ligament, partially aponeurotic in texture, which extends medially from the white line of the pelvic fascia to the viscera." But they also add that the manner of its origin and condition of its special differentiation are subject to very great variations, and they do not explain how such a structure arose.

The same authors also disagree with the description given above of the cardinal ligaments, and in this they share the opinion of Bonney (1947). They confine the term cardinal ligament to the most caudal portion of the parametrium only. Uhlenhuth et al. name the lateral point of "origin" of the ligament as 1½ inches anterior to the ischial spine, where the uterine artery leaves the pelvic wall and turns medially. Bonney states that the cardinal ligament is entirely paravaginal. It is true that it is only at this low level that the vascular bundle bridges the gap between the pelvic wall and the viscera, but it would seem more correct to describe the whole of the sheet together. Bonney also asserts that this tissue is avascular, whereas all other descriptions stress the abundance of blood vessels, especially veins, in the paravaginal connective tissue.

Uhlenhuth/
Uhlenhuth et al. further describe, from the evidence of dissections, special voluntary muscle fibres from the levator ani passing into the root of the cardinal ligament near the above-mentioned point of origin. They claim that this portio cardinalis of the levator fixes the ligament to the pelvic wall. No other studies have demonstrated this point of anatomy. Smout and Jacoby (1946) are the only authors who describe the presence of voluntary muscle fibres in the parametrium.

The remaining named portions of the connective tissue are again in relation to blood vessels. Running forward from the main vascular sheath to the posterolateral aspect of the bladder is the misnamed vesico-uterine ligament, or sagittal part of the bladder septum (Peham and Amreich) or inferior hypogastric wing (Uhlenhuth). This is the sheath around the inferior vesical venous plexuses, and in its caudal portion it ensheaths the terminal part of the ureter also. It is continuous anteriorly with the lateral pubovesical ligament below and lateral to the bladder. At a higher level in the pelvis, there is a sheet of connective tissue extending laterally from the lateral margin of the superior surface of the bladder to the obliterated umbilical artery. It proceeds upwards as a triangular process between the lateral umbilical ligaments to the umbilicus. It is continuous posteriorly with connective tissue of the main vascular bundle. It invests the superior vesical vessels as they course medially to the bladder. It is a lamina retracted laterally from the sheath of the allantois by the umbilical artery during development, and has therefore been called by Delbet the allantoic sheath. Other names are the superior hypogastric wing (Uhlenhuth), the vesico-hypogastric fascia and umbilical ligament (Peham and Amreich), the false lateral ligament of the bladder.

THE UTERO-SACRAL LIGAMENTS.

These are a pair of weak bands occupying the recto-uterine fold of peritoneum (Cunningham, 1943; Jamieson, 1947.) Although they have sometimes been credited with an important role as supports, most anatomical descriptions speak of their insubstantial nature. Curtis et al. (1940) state that the sacral extremity is of such even contour that it bears little resemblance to a true ligamentous band. Fothergill (1908) states that as supports they "demand no further consideration."

Many authors describe them as an extension posteriorly of the neurovascular sheaths (Cameron (2) 1907-8; Close. 1947.) On each side of the posterior pelvis, between the rectum and the posteromedial surface of the main neurovascular sheath, there is traceable a crescentic layer of more condensed connective tissue, following the curve of the pelvic wall. It is called the rectal septum (Peham and Amreich) or the presacral hypogastric wing (Uhlenhuth et al.) It ensheaths the hypogastric and pelvic autonomic nerve plexuses, running forward, the middle rectal vessels, passing to the rectum, and on the left side the sheath of the superior rectal vessels is incorporated in it. The utero-sacral ligaments are described as a medial projection from this layer. (Peham and Amreich) Curtis et al. (1940) state that the connecting bridge with the posterior leaf of the vascular compartment, though more condensed than areolar tissue, is not particularly firm.

A/
A most comprehensive study of the gross and microscopic anatomy of the utero-sacral ligaments has been presented by Campbell (1950). In summary, he states that grossly they are often merely potential ligamentous structures. Histologically they may be divided into thirds. The anterior or cervical third contains in order of prominence smooth muscle, fibroelastic connective tissue, blood vessels, nerves, and lymphatics. The intermediate third is made up of connective tissue concentrated in a suberosal stratum fibrosum, and scattered in the deeper zone as a less dense meshwork. Nerve elements are numerous and blood vessels are moderately prominent. There are also a few scattered strands of smooth muscle in this region, and lymphatics may be present to a variable extent. The posterior or sacral third is composed almost entirely of loose strands of connective tissue and intermingling fat. There are few vessels, nerves, and lymphatics located there.

THE ROUND LIGAMENT.

This is a flattened cord, mostly of fibrous tissue, but including an admixture of plain muscle fibres from the myometrium at the uterine end, and of voluntary muscle fibres from the internal oblique and transversus muscles at the ventral end. (Smout and Jacoby) It has no supportive function under normal conditions, though it may well act as a stay during pregnancy. It is, of course, a part of the genito-inguinal ligament, and Fothergill remarked that its purpose was to pull organs down during foetal life, not to hold them up throughout postnatal life! That the ligament is not even responsible for maintaining the normal antverted position of the uterus was strikingly demonstrated by Mackenrodt, who, at laparotomy, divided both ligaments and placed loops of bowel in front of the uterus. After keeping the patients supine during the post-operative period, he found that the uterus remained in the antverted position. Such Teutonic thoroughness is rather startling, but certainly afforded a convincing proof of Mackenrodt's contention.

CONCLUSION.

In this essay, I have lingered over a host of anatomical minutiae, and a few more general principles, rather than drawn any very sweeping conclusions as to the supporting role of any particular tissues. But this is as it should be, since an intimate survey of the anatomy must precede any theories of the dynamics of visceral support. Further, much of the evidence presented has been of a rather iconoclastic sort, more of value in showing what does not and cannot support the pelvic viscera than in describing positively the supportive mechanism. Certainly many accounts, both recent and old, of the supports of the pelvic urogenital organs, and of the etiology of prolapse, lack an accurate anatomical foundation.

A few general observations are worthy of re-emphasis:
- The pelvic floor must be considered as a whole. The structure of a building may include several different frameworks, pillars, and buttresses of different materials - steel, wood, stone, but the strength of the building lies in the unity of them all.
- There is no single anatomically outstanding visceral support. The position of the organs is maintained by the whole of the surrounding tissues, and no one part should be singled out or considered in isolation.
- The fact is often lost sight of that the pelvic connective tissue follows the same anatomical principles of development and disposition as does the connective tissue of the rest of the body.

The anatomy, physiology, and pathology of micturition require much further elucidation.
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