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ANATOMY OF THE INGUINAL REGION.*

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This paper is limited to the region of the inguinal canal and enters into a description of such portions of the various structures as are directly included in this territory.

The observations are based on some fifty dissections. They have been compared with the descriptions in Toldt, Spalteholz, Morris, Gray, Deaver and Zukerkandel and found to be somewhat at variance with them. These textbooks were selected as representative of the anatomies usually referred to. A few monographs on the subject have been consulted with the same results. It would carry the paper to too great lengths to discuss these differences in connection with the findings here presented. This lack of uniformity of description has led to the publication of the present paper, in which are included such original drawings as are necessary to illustrate the text.

Fig. 1.—Abdominal wall face of a cast of the inner face of the inguinal region after removal of the peritoneal coat. (About 3/5 natural size.)

The old nomenclature has been adhered to, although the terms often convey false ideas because of the anatomic misconceptions at the time they were adopted.

The structures which enter into the region under consideration are peritoneum, extraperitoneal fatty tissue, three muscles, four fascias and the so-called conjoined tendon.

The peritoneum had lost all evidence of the processus vaginalis in the adult subjects. Three full-term fetuses were dissected, in two of which it was widely patent, in the third closed. Judging from statistics of inguinal hernia, it is safe to say that the processus vaginalis of the peritoneum closes in the very large majority of persons during the first four years of life.

The extraperitoneal fatty tissue is continued into the inguinal canal at all ages. It is a most important

structure in its relationship to the inguinal canal. Surrounding the cord loosely attached to it, this tissue affords an easy passageway between the abdominal cavity and the scrotum, with but the thin layer of peritoneum acting as a barrier to a potentially open route. The large blood vessels and the spermatic cord are surrounded by this tissue in their course within the abdomen. In their immediate neighborhood the fatty tissue is thickened by bundles of rather dense connective tissue, which serves as a support. In the median direction from the internal abdominal opening it can be separated into three distinct layers; one passes posterior to the bladder, the other two anterior to it. These three layers encase the bladder in a fatty envelope of triangular outline, the base below and the apex above. In the fetus the hypogastric arteries and in the adult the remains of these arteries mark the lateral borders of this triangle. Lateral to this triangle the fatty tissue can not be divided into separate layers. Separation from the abdominal wall can be readily accomplished in this region except in the line of union of the iliac and transversalis fascias (Fig. 4, J). Immediately surrounding the deep epigastric arteries and lateral to them are a number of dense connective tissue bundles which are

Fig. 2.—Pelvic wall face of cast, showing: A, Hesselbach's ligament and deep epigastric vessels; B, Superior ligament of the bladder; C, spermatic vessels; D, vas deferens. (About 3/5 natural size.)

developed in the fatty tissue and which extend from the inner margin of the internal abdominal opening to the outer end of the semi-lunar fold of Douglas. The fatty tissue is closely connected with the outer-lying transversalis fascia in the route of these bundles, and together they give the appearance of a ligament which is known as Hesselbach's ligament (Fig. 3, B). This structure plays a most important part in rendering the inner end of the inguinal canal patulous during increased intra-abdominal tension. The resistance offered by it, in conjunction with the deep epigastric vessels, is well shown in Figures 1 and 2, reproduced from a cast made by taking an impression of the abdominal surface of the inguinal region with the peritoneum removed. The best quality of dental wax, made soft by heat, was tightly pressed against the region of the inguinal canal. The deep epigastric vessels and Hesselbach's ligament stand out well from the wall under

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this pressure and make a depression in the wax (Fig. 1, A). The portion of the cast median to the depression (A), that is, in the direction toward B, corresponds with that area of the abdominal wall formed chiefly by the conjoined tendon. The portion of the cast lateral to the depression corresponds to the wall between the internal abdominal ring and the anterior superior spine of the ilium. This latter area is muscular. These two planes are seen to be anterior to Hesselbach's ligament, which stands out from the wall a centimeter or more when the wall is subjected to pressure. There is not much discrepancy between the outer and inner plane in the normal individual, but when the muscle area, which forms the wall represented by the outer plane, weakens through disease or age this dis-

Fig. 3.—Dissection of the inner aspect of the inguinal region after removal of the peritoneum, showing: A, Deep epigastric vessels; B, Hesselbach's ligament; C, vas deferens; D, spermatic vessels; E, internal abdominal opening.

Fig. 4.—Dissection of the inner aspect of the inguinal region after removal of the fatty tissue, and portions of the iliac vessels and transversalis fascia, showing: F, Fibers out of the deep crural arch passing medianward; G, fibrous bundles which come out of the true pelvis and pass on to the abdominal wall; H, femoral opening; I, opening of the inguinal canal in the fascia transversalis; J, line of union of the iliac and the transversalis fascias; K, Cooper's ligament.

crepancy becomes marked. This difference in the two planes readily explains how hernias form, the bowel slipping anterior to Hesselbach's ligament and down the inguinal canal. Figure 2 represents the under side of the cast. The vas deferens (D) and spermatic vessels (C) are easily traced. The indenture in the cast between these two structures is made by the brim of the true pelvis.

The inguinal canal has an oblique course through the abdominal wall from within outward, passing medianward and downward. The fatty tissue passes into and through the canal in an almost straight line from the lateral border of its inner end. From the median border it passes into the canal sharply flexed, giving to the median edge of the internal abdominal opening a falciform appearance. The internal abdominal opening of the inguinal canal, which is situated in this fatty tissue, is shown in Figure 3, E. It is found just above the junction of the anterior abdominal wall and the floor of the false pelvis.

The transversalis fascia is shown in Figure 4; from it a

window has been cut internal to the large vessels to show the outer-lying structures of that area. This fascia is not of uniform thickness, being quite thin in the region under the transversalis muscle, but thick enough in the region caudad of the arching lower fibers of that muscle to offer material support to the abdominal wall. Behind the rectus it is again thin and hard to distinguish from the fatty tissue. The transversalis fascia unites with the iliac fascia just internal to the origin of the transversalis muscle. It leaves the iliac fascia lateral to the iliac vessels and arches over them to the ilio-pectineal line median to the vessels. The intramuscular fascias between the transversalis muscle and internal oblique and between the internal and external obliques join the transversalis fascia in this arch to form the deep crural arch (Fig. 7, E). The transversalis fascia in this plate has been removed from the muscle and cut off along the edge of the arch to allow a view of other structures. Figure 4 gives the internal view of the arch. A number of dense fibers are developed in the deep crural arch which pass medianward across and internal to the lower portion of the conjoint tendon. These serve to hold the lower portion of the tendon in line with the abdominal wall. The transversalis fascia forms the second layer covering the spermatic cord. The description of the manner in which the fatty tissue enters the inguinal canal is applicable to this fascia.

External to the pelvic and iliac fascias and extending on to the abdominal wall to become

Fig. 5.—Dissection of right inguinal region showing: A, Fibers coming out of the pelvis in this subject constituting the whole of the so-called conjoint tendon; B, transversalis muscle; C, cremasteric muscle and fascia from the internal oblique.

Fig. 6.—Dissection of left inguinal region, showing: A, External oblique muscle; B, cremasteric muscle from transversalis; C, internal opening of the inguinal canal through the transversalis fascia; D, transversalis fascia; E, fibers out of the pelvis which pass into the so-called conjoint tendon; F, aponeurosis of the transversalis muscle; G, internal oblique.

a part of the structure known as the conjoint tendon are a series of dense connective tissue fibers, quite ligamentous in appearance (Fig. 4, K, G). The lateral half of this structure (K), lying chiefly under and lateral to the iliac vessels, is known as Cooper's ligament. The fibers are lost below (caudad) under the femoral sheath posterior to the vessels as they pass into the thigh. The median half of this ligamentous structure is found beneath the pelvic fascia caudad of the ilio-pectineal line. It passes out of the pelvis over the ilio-pectineal line and on to the abdominal wall median to the iliac vessels (Fig. 4, G). In certain persons this structure constitutes the whole of the conjoint tendon, and in all more or less of the fibers enter it. Figure 5, A, represents the appearance of the area when the conjoint tendon is wholly formed by this structure. The median edge of the femoral opening is bordered by its lateral fibers (Fig. 4, H). In conjunction with the deep crural arch these cause constriction of the neck of a femoral hernia. In Figure 4 there is seen a triangular area lying between these ligamentous fibers (G), the deep crural arch (F) and the rectus muscle. This area is usually formed by the aponeurosis of the transversalis muscle, helping to form the conjoint tendon. Between G and Hesselbach's ligament the space is strengthened by the transversalis fascia. The median or lowermost fibers of

this structure course along the ilio-pectineal line to meet, behind the symphysis pubis, similar fibers from the other side.

The transversalis muscle takes origin from the continuation of the iliac fascia, caudad of the line of union of this fascia with the transversalis fascia. The extent of origin of the muscle from the iliac fascia varies, not only in different subjects, but also in the same subject on the two sides (Figs. 5 and 6). This may be stated to be under or within the outer half to one-third of Poupart's ligament. The lowermost fibers of this muscle take an inward and downward course over the internal abdominal ring to find insertion into the ilio-pectineal line for a variable extent. This insertion varies from a fraction of an inch to an inch and more. In some subjects, however, the muscle passes to the body of the pubis or even only to the linea alba, finding no bony insertion at all (Fig. 5). That portion of the muscle finding insertion into the ilio-pectineal line is usually described as forming with the internal oblique the conjoined tendon. This is never true. The transversalis (Fig. 6, F) becomes quite aponeurotic just before its insertion into the ilio-pectineal line and lies anterior to the ligamentous structure (Fig. 6, E). In Figure 6 the anatomic arrangement of the conjoined tendon is quite normal. The transversalis fascia is indicated by D, a window being cut out of it to show the relation of the deep epigastric vessels to this

Fig. 7.—Further dissection of the left inguinal region, showing: A, External oblique; B, internal oblique; C, transversalis; D, cremasteric muscle and fascia; E, deep crural arch; F, aponeurosis of the transversalis; G, rectus muscle; H, peritoneum covering the intestines.

Fig. 8.—Further dissection of the left inguinal region with greater portion of cremasteric fascia, removed, showing: I, Femoral sheath; K, fascia lata; L, Gimbernat's ligament; M, cremasteric fascia; N, external oblique.

area. The ligamentous structure is indicated by E and the transversalis muscle by F. Figure 5 shows the other extreme of the relationship of the structures forming the conjoined tendon. It is here made up of only the ligamentous structure. Figure 7 shows an anatomic condition in which the transversalis muscle forms a distinct, compact aponeurotic lamina and finds insertion into the whole of the ilio-pectineal line median to the iliac vessels. Very few of the ligamentous fibers entered the conjoined tendon in this subject, but passed almost wholly behind the insertion of the rectus to unite with similar fibers from the opposite side.

The cremaster muscle consists at times of a few of the lowest fibers of the transversalis, having been carried into the scrotum by the descending testis (Fig. 6, B). Its fibers returning upward are inserted into the ilio-pectineal line just lateral to the insertion of the transversalis proper. The musculus interfoveolaris consists of a few bundles derived from the posterior surface of the transversalis muscle and is inserted into the transversalis fascia just median to the internal abdominal opening. It is not constant.

The lower fibers of the internal oblique take origin from the iliac fascia parallel to and caudad of that of the transversalis muscle. The extent of this origin may be said

to be under the outer half of Poupart's ligament. The course of the fibers is from without inward and downward, but not quite so caudad in direction as that taken by the transversalis muscle. The internal oblique is, as a rule, quite closely connected with Poupart's ligament through its anterior fascia. Likewise some of the fibers of the internal oblique in many subjects become aponeurotic and enter Poupart's ligament near its middle. This secures a close union of the two muscles. The lowest fibers of the muscle are inserted into the pubic bone below and anterior to the transversalis muscle. These arch over the cord in front of the internal abdominal opening. The variableness of this feature has been repeatedly mentioned by different anatomists. From the lower edge of the internal oblique its fascias pass downward, cover the spermatic cord, surround the cremaster muscle and find insertion into the ilio-pectineal line. This fascia constitutes the cremasteric fascia and helps to form the deep crural arch anterior to the iliac vessels (Fig. 7, D, and Fig. 8, M).

The features to be mentioned in connection with the external oblique chiefly concern Poupart's-Gimbernat's ligament. Gimbernat's ligament (Fig. 8, L) is a most variable structure, consisting of those fibers of Poupart's ligament which turn posterior and medianward to be inserted into the ilio-pectineal line parallel with and external to the insertion of the cremaster fascia. These fibers are closely attached to the fascia lata of the thigh. Its inner border lies parallel with the deep crural arch, external to it. The intercolumnar fibers are derived from the lowest fibers of the external iliac aponeurosis. They cross the external abdominal opening at its apex and spread out in a fan-shape manner. Some of these aponeurotic fibers can be traced into the fascia lata below Poupart's ligament and are inserted into the ilio-pectineal line under Gimbernat's ligament. They lie within the falciform process of the fascia lata lateral to the cribriform fascia. The external abdominal opening in the external oblique is covered in by the peria-poneurosis (deep fascia of the abdomen). This peria-poneurosis is pushed forward as a covering of the cord, and the opening which the cord apparently makes is known as the external abdominal ring. This ring is strengthened by a number of dense fibers, which encircle its upper and outer border.

The ilio-inguinal nerve lies anterior to the cord as it passes out of the abdominal wall and the genito-crural posterior or internal to it. This latter nerve enters the canal median to the internal abdominal opening and passes through the canal anterior to the cremasteric fascia and posterior to the cord.

SUMMARY.

The internal abdominal opening is located in the extraperitoneal fatty tissue.

Hesselbach's ligament is formed by fibrous bundles which connect the outer end of the semi-lunar fold of Douglas with the inner margin of the internal abdominal opening. These bundles are developed chiefly in the extraperitoneal fatty tissue. Along the route of these bundles there exists between the fatty tissue and the transversalis fascia a close union. During intra-abdominal pressure, Hesselbach's ligament, due to its resistance, helps to increase the size of the internal abdominal opening.

In the inguinal area the internal surface of the abdominal wall is divided into two planes by Hesselbach's ligament. Normally, the plane lateral to this ligament is only slightly anterior to the plane median to the liga-

ment. When the muscles of the lateral plane are weakened by disease or are enfeebled through advanced age intra-abdominal tension greatly exaggerates this difference. As the internal abdominal opening is situated at the junction of these two planes, the greater the difference the more patulous the opening and the greater the possibility of escape of a viscus through the opening.

The transversalis fascia does not join Poupart's ligament at any point.

The deep crural arch is formed by the junction of the transversalis and cremasteric fascias in the arch in front of the external iliac vessels as they pass into the thigh. The free (posterior) edge of Gimbernat's ligament is just external to and parallel with the deep crural arch.

The fibrous bundles which pass out of the pelvis into the so-called conjoined tendon give to the abdominal wall its chief strength internal (posterior) to the inguinal canal. The aponeurosis of the transversalis muscle strengthens the wall just internal (posterior) to the external abdominal ring.

The base of the so-called conjoined tendon, the lateral margin of which is formed by the fibrous bundles which enter the tendon from out of the pelvis, is the constricting agent in femoral hernia. A Spanish surgeon, Gimbernat, attributed this agency to the structure which has since been given his name.

The so-called conjoined tendon was in no instance formed by a union of fibers from the internal oblique and transversalis muscles in the subjects dissected. Judging from the usual anatomic arrangement this union seems quite impossible.

The external abdominal opening is situated between the dividing fibers of the aponeurosis of the external oblique muscle. The external abdominal ring is situated in the peria-poneurosis which covers the external abdominal opening.

FATIGUE.*

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It is a striking principle of biology that the activity of living substance tends to inhibit its further activity. Carried to a moderate degree, this inhibition leads to the self-preservation of the living substance—to an extreme degree, to its self-destruction. The characteristics of this inhibition, its accompanying phenomena within the organism and the causes that lead to it form the subject of the present lecture. Fatigue is a comprehensive term, comprising, in its simple form, the functional state of the organism and its constituent parts after activity. Lying on the border zone where the physiologic and the pathologic meet, it reaches far into both and obscures the division lines between them. When present in slight or moderate degree, it limits achievement, but is easily recovered from; when excessive or an accompaniment of disease, it forms a serious condition, which, if in man, the medical practitioner must meet and combat.

Fatigue is a universal biologic phenomenon. The activity, however slight, of living substance, wherever found, reveals its beginnings. While it has been studied chiefly in the muscular and nervous tissues, it has been pointed out elsewhere, and our recognition of its signs

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