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Anatomy of the inguinal region

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THE ANATOMY OF THE INGUINAL REGION

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Introduction

Hernia is an anatomical disorder and thus it is probably one of mans' oldest maladies. Celsus in the First century A. D. gave the medical world the first written account of hernia. His conception as to the anatomy, pathology, and treatment were rather modern. He differentiated various types of hernia and recommened that the margins of the weakened region be sutured together after the base of the protruding mass had been ligated. Due to the fall of the Roman Empire and the resulting dark ages Celsus (1) work was the last significant contribution until the dawn of the modern surgical era. During the dark ages numerous methods of treatment were used for the relief of hernia and the majority were barbaric. Although this period offered little for the advancement of the surgical treatment of hernia the foundation for an intelligent approach was being laid. The anatomy of the inguinal region was thoroughly studied by men whose names are still associated with structures in that area.

Beginning about 1600, post-mortem examinations became very common, and from 1600 to 1850, the various hernias, contents of the sacs, and the various anatomic relationships of hernias were fairly well catalogued. The works culminated during this period with the publications of Scarpa in Italy and Cooper in England.

Praxagoras in 300 B.B. had advised taxis in the treatment

of strangulated hernis, but this was abandoned until 1650, when Pierre Franco dissected the hernial sac, enlarged the in-guinal ring and reduced the hernia without opening into the peri-toneum. From the time of Franco until recent times strangulation of hernia was the chief indication for the performance of herni-otomy. It was in the treatment of strangulated hernia that the canal was first opened. Advancement in hernial surgery was made by Guy D. Chauliac, who was the first to recognize femoral hernia and to separate it from the inguinal hernias. In 1731 Gimbernat described his ligament and taught the enlargement ofthe femoral ring by cutting medially through this ligament. Sir Astly Cooper described his ligament in 1804, and described how to utilize it in the treatment of femoral hernia.

Direct inguinal hernia was discovered in 1724 and first described by Heister. Hesselbach in 1814, clearly described the inguinal anatomy and named his triangle. In 1841, Morton described the conjoined tendon. (2, 3, 4)

Due to the high incidence of inguinal hernia numerous contributions dealing with the anatomy have been made during the last 100 years.. As a result much confusion has resulted. The con-fusion has been due to several factors; (1) many publications were based on one dissection, (2) sharp dissection methods resulted in artifacts which were considered to be true anatomic

structures and (3) a wide variety of terms were used in the discriptions. The present investigation was undertaken in order to, (1) present thepresent day anatomic picture as it appears to the majority of investigators and (2) to emphasize, by presenting two dissections that the region varies. The latter point stress-ing the fact that the surgical technique employed must suit the presenting anatomy.

Materials and Methods

Two white adult male cadavera that showed no external evidence of inguinal hernia were used for the dissections.
Through out the dissections blunt dissecting techniques were used when possible in order to reduce the production of artificial layers. The basic technique consisted of a mid-li ne incision extending from the pubic synphysis to the umbilicus. A transverse incision about 2 cm. inferior to the umbilicus was made extending between two vertical lines passing through the anterior superior iliac spines. The individual layers beginning with the superficial and progressing inward were reflected laterally. The inferior attachments were left intact except for the inguinal ligament which was divided in its middle in order to permit better exposure.

Observations

The two random dissections consisting of four inguinal regions presented marked contrast. One cadaver revealed the classic picture which is described in the discussion. The other dissection followed the classic pattern except for the inferior attachments of the internal abdominal oblique muscle and the corresponding alterations of the cremaster muscle. The internal abdominal oblique muscle, laterally, had the classic origin from the intermediate portion of the iliac crest, the more medial fibers instead of arising from the lateral third of the inguinal liga-ment arose from the fascia of the iliacus muscle. This arrangement left the inguinal ligament completely free of the internal oblique. Medially the internal oblique joined the conjoint tendon in the classic fashion. The cremaster muscle was altered in that the laterally placed fibers arose from the iliac fascia and coursed along the anterior inferior aspect of the spermatic cord, at the superficial inguinal ring the fibers coursed poaterior to the cord then passed anterior and medial to the femoral vein with attachment to the ilieo-pectineal extension of the lacunar ligament. These fibers were predominately fleshy in character. The remainder of the cremaster fibers formed loops about the

spermatic cord and inserted into the pubic tubercle in the classic manner. The vessels and nerves showed no alteration from that generally desribed.

Discussion

This discussion departs from the usual form in that it is to serve several ends. One purpose is to describe the inguinal anatomy as it is taught in most medical schools today and in so doing report on one of the dissections considered in this investi-gation. Differences of opinion will be discussed and the various synonyms will be recorded. The description will procede from the more superficial to the deep layers.

The inguinal region in general is bounded inferiorly by the inguinal ligament, superiorly by a horizontal line extending from the anterior superior iliac spine to the linea semilunaris, with the latter representing the medial border.

Immediately deep to the skim is the superficial fascia which contains varying amounts of fat. The superficial fascia is divided into two layers, (1) the superficial fat containing layer known as Gamper's fascia which is continous with the superficial layer covering the remainder of the body; (2) immediately

caudal to the level of the umbilicus the superficial layer condenses and gives rise to the membranous layer which is commonly termed Scarpa's fascia. The membranous lager is absent superior to the umbilicus. Laterally the layer thins out and disappears on a more or less vertical line just lateral to the anterior superior iliac spine, inferiorly the fascia attaches to the fascia lata about 1.5 cm. inferior to the inguinal ligament. In the midline the membranous layer is adherent to the linea alba except just above the pubis, at this point it descends as the fundiform ligament to the dorsum of the penis. The fundiform ligament is separated by an areolar space form the suspensory ligament of the penis which has its origin from the deep fascia (5). In the perineum the membranous layer is known as Colles' fascia.

The deep fascia (fascia innominata; Gallaudet's fascia) re-sembles similar fascia in other situations. It form an for the external oblique muscle and becomes thin and almost investment imprecptible in reation to the aponeurosis of that muscle.

External Abdominal Oblique Muscle-- The insertion of this muscle contributes much to the inguinal anatomy. The most posterior fibers of the muscle insert into the anterior half of the external lip of the crest of the ilium. The su erior and the middle

fibers are directed obliquely downward and forward and end in a strong aponeurosis. Inferiorly the aponeurosis is strong and its lower margin forms the inguinal ligament. The aponeurosis interdigitates with the contralateral one in the midline thus contributing to the formation of the linea alba.

The inguinal ligament (Poupart's ligament) attaches to the anterior superior iliac spine laterally, it then spans the superior pubic ramus to attach medially to the pubic tubercle. The medial attachment is complex in that it gives rise to the lacunar and reflected inguinal ligaments. Some of the inguinal fibers terminate at the pubic tubercle while others curve posterio-laterally onto the iliopectineal line of the superior pubic ramus and give rise to a cresent shaped fibrous structure called the lacunar ligament (Gimbernat's ligament). The apex is attached to the pubic tubercle and its base is concave and free.. Those fibers which continue along on the iliopectineal line are refered to as the pectineal ligament (Cooper's ligament). The reflected, or reflex, inguinal ligament is a small triangular sheet of fibers woven into the aponeurosis of the external oblique Muscle. The ligament arises from the crest of the pubic bone and the medial end of the iliopectineal line, wherefrom it courses upward and medialward, undercover of the superior crus of the subcutaneous

inguinal ring to join the linea alba. Some of the fibers ex-tend beyond the midline to become continuous with the fibers of the aponeurosis of the external oblique of the opposite side. According to Holyoke (6) this view is not sound. He states that the reflected inguinal ligament consists of fibers from the contralateral external oblique muscle which cross the midline and insert into the iliopectineal line rather than arising from it. This view certainly appears to be a more logical explanation. Anson (2) reports that the ligament maybe absent or poorly developed.

The superficial (subcutaneous) inguinal ring is a gap in the external abdominal oblique muscle. It is the interval left between that portion of the aponeurosis of the external oblique muscle which forms the inguinal ligament and the in-ferior crus and that part which terminates as the superior crus. The inferior crus is narrow and is fixed to the pubic tubercle. The superior crus, flat and broad, is the part of the aponeurosis which is attached to the pubic crest and symphysis. In the male the superficial inguinal ring transmits the spermatic cord, in the female it transmits the round ligament of the uterus. The opening is variable in width and is triangular in outline; its edges are drawn together by a thin fascia, strengthened superficially by a number of arched and horizontal fibers known

as intercrural fibers, which arise from the inguinal ligament and sweep medially across the cleft in the aponeurosis. As the spermatic cord emerges through the ring it carries a fascial covering with it which is known as the external spermatic fascia. Lockhart (7) reports that the external spermatic fascia is a continuation of the intercrural fibers. On the other hand, McVay and Anson (8) state that the fascia is bilaminar being composed of the deep fascia found on either side of the external abdominal oblique muscle. Holyoke (6) supports the latter point of view.

Internal Abdominal Oblique Muscle-- Classically this muscle arises from the lateral half of the grooved abdominal surface of the inguinal ligament, from the intermediate line of the anterior two-thirds of the iliac crest and from the vertebral column through the intermediation of the lumbodorsal fascia. The general direction of the fibers is from below upward and medial-ward. The lowest fibers, from their origin on the inguinal lig-ament, arch downward and medialward. Upon joining with the lowest fibers of the transversus muscle they pass in front of the rectus muscle as part of the latters sheath to an insertion on the pubic crest and the iliopectineal line, behind the lacunar ligament and the reflex inguinal ligament. At the

lateral margin of the rectus muscle the aponeurosis of the internal oblique splits into two lamellae. The superficial layer passes in front of the rectus and fuses with the aponeu-rosis of the external oblique. The deep layer is prolonged medialward behind the rectus and fuses with the aponeurosis of the transversus muscle. This arrangement, however, is not present in the area inferior to a point about midway between the umbilicus and the pubis. In this region the entire aponeu-rosis of the internal passes in front of the rectus. The fascicles of the lower third of the internal oblique muscle,

as they leave the iliac spine, follow either a transverse or an oblique course and typically the fibers terminate near the linea semicircularis. Usually in the male, the lowermost fibers of the internal oblique curve downward, pass over the spermatic cord and attach to the tubercle and pecten of the pubis; they are especially named aponeurotic inguinal falx (conjoined ten-don) There is some question as to the term falx as it has given rise to misunerstanding. The latin term falx means sickle shaped. The falx like nature of the medial attachment becomes apparent only after the cremaster muscle fibers have been retracted laterally, the falx per se is an artifact. This view is strongly urged by Anson (8), Holyoke (6) and is supported by the authors' observations. However, it should be pointed out

that a union still exist between the medial fixations of the internal oblique and the transversus muscles, thus the term conjoined tendon appears to be more appropriate than the term falx inguinalis.

Cremaster muscle (Greek-suspended). As a general rule this muscle arises from the inferior edge of the internal oblique and the adjacent part of the inguinal ligament. Holyoke and the author support the point of view that the transversus muscle may also contribute fibers to the cremaster muscle. The fleshy fibers of the cremaster descend upon the antero-lateral aspect of the cord in the form of festoons, the longest of which reach the tunica vaginalis of the testes and the shortest go no farther than the subcutaneous inguinal ring. The loops ascend on the posterior aspect of the cord, to gain a tendinous insertion into the pubic tubercle and crest. The spaces between the festoons are occupied by a downward prolongation of the fascial investment of the internal oblique and is refered to as the cremasterfascia.

Transverse abdominal muscle. In the inguinal region the transverse abdominal muscle arises from the lateral third of the inguinal ligament and the anterior two thirds of the internal lip of the iliac crest. Anteriorly, the fibers end in a strong aponeurosis which is inserted into the linea alba, the pubic

crest and the iliopectineal line. As the aponeurosis is neared the fleshy fibers in general run in a transverse di-rection. The lower fibers, however, take a curved course downward and medially, resulting in an arched lower border for the muscle. On occasion muscle fibers may arise from this arched border on the medial side of the internal inguinal ring and form a thickening in the fascia transversalis which connects below to the inguinal ligament, it is refered to as the ligamentum interfoveolare. This term is now officially recognized by the Sixth International Congress of Anatomists.

The fleshy fibers of the transverse abdominal muscle give way to an aponeurosis, which, as a constituent of the rectus sheath and the so called inguinal falx, gain insertion into the pubic crest and into the iliopectineal line. The aponeurotic insertion of the transverse muscle is longer than that of the internal oblique.

The three flat muscles desribed are supplied by the anterior branches of the lower six thoracic nerves and by the anterior branch of the iliohypogastric nerve.

Anson (8) reports that the transverse abdominal muscle is usually more aponeurotic in the inguinal region than is the internal oblique; thus, although in 97 per cent of the cases the muscular part of the internal oblique extends inferiorly

as far as the spermatic cord, in only 3 per cent did the muscular portion of the transversus reach that level; in 62 per cent, it terminated within the superior half of the inguinal region, in 7 per cent it did not reach the anterior superior spine of the ilium; in approximately 19 per cent of the cases the layer was almost as aponeurotic as the external oblique in the same subject, the muscle fibers terminating at or near the intertubercular line.

According to Chouke (9) the transverse muscle in many specimens is carried outward from the abdominal inguinal ring as a thin contribution to the layers of the spermatic cord. This is what many investigators refer to as the contribution of the transverses to the formation of the cremaster muscle. Chouke claims, however, when muscle fibers are exchanged between the transversus and internal oblique muscles, the relationship is likely to be dependent upon the occurrence of the accessory internal oblique muscle which intervenes between the internal oblique proper and the transversus. The author has not observed this accessory muscle.

Transversalis fascia. Deep to the transversus muscle is a discernible fascia known as the transversalis fascia. Superiorly the fascia is thin and is continuous with the fascia which invests the abdominal surface of the diaphragm. Medially

it is continuous with the fascia of the opposite side behind the sheaths of the recti muscles. Posteriorly it is continuous with the fascia of the quadratus lumborum and psoas muscle. There is still question existing as to its posterior termination. Does it cross the posterior midline to the opposite side or is it carried out into the mesentery? Laterally the fascia attaches to the internal lip of the iliac crest and is continuous with the fascia of the iliacus muscle. Anteriorly, in the inguinal region, its attachments and continuities are more complex: between the anterior superior spine of the ilium and the femoral artery, where it is attached to the inguinal ligament, the fascia is continuous with the iliac fascia; opposite the femoral vessels, it is prolonged distally into the thigh deep to the inguinal ligament as the anterior part of the femoral sheath; medial to the femoral vessels, it is attached to the pectineal line of the superior pubic ramus.

Occupying the gap between the lower arched border of the transversus muscle and the inguinal ligament the transversalis fascia compensates for the transversus muscle and forms the posterior wall of the inguinal canal. In this interval the fascia is prolonged downward upon the spermatic cord investing it in a tube of fascis known as the internal spermatic

fascis (infundibuliform fascia). The transversalis fascia exhibits its greatest strength in the inguinal region.

Deep to the transversalis fascia is found the preperitoneal tissue, lobules of which are carried into the inguinal canal encased in the internal spermatic fascia. The preperitoneal tissue is lined on its deep surface by the peritoneum.

When the above discribed structures are put together the inguinal canal is formed. The canal is about one and a half inches long, it begins at the deep (internal, abdominal) inguinal ring which is an area of evagination in the fascia transversalis, half an inch or less above the inguinal ligament, and end at the superficial (external, subcutaneous) inguinal ring which is an area of evagination in the external oblique aponeurosis immediately above the pubic tubercle and the medial end of the inguinal ligament. The anterior wall of the canal is formed by the aponeurosis of the external oblique, and in its lateral part by the muscular fibers of the internal oblique;the posterior wall of the canal is formed by the fascia transversalis, and in its medial part by the inguinal falx (conjoined tendon) and by the reflected part of the inguinal ligament when that structure is well developed. In those cases in which the tendon of the rectus abdominis muscle is

expansive the lateral portion of the tendon reinforces the deep surface of the falx inguinalis and is known as Henle's ligament, according to Goss. Holyoke, on the other hand, believes that Henle's ligament is derived from the transversus rather than the rectus. The fibers pass deep to the subcutaneous ring and lateral to the lateral border of the conjoined tendon where it attaches to bone. Porries and Charpy (11) describe Henle's ligament as coming from the margins of the linea semicircularis (not -lunaris). The fibers reinforce the transversalis fascia in which they are embedded and together with the interfoveolar ligament are responsible for the conception that the transversalis fascia is strong in the inguinal region. Without them it is not.

The anterior wall of the inguinal canal is strongest opposite the deep inguinal ring, and the posterior wall opposite the superficial ring. The floor of the canal is formed by the inguinal ligament, and medially by its pectineal part; the roof is formed by the arching fibers of the internal oblique and transversus muscles. The spermatic cord, evaginating the transversalis fascia enters the inguinal canal at the deep inguinal ring, and is there invested by its first coat, the internal spermatic fascia, a sheath derived from the margins of the ring and continuous with the

fascia transversalis. The cord then passes obliquely medially, downwards, and forwards, and escapes below the lower border of the internal oblique muscle, from which it carries off a second coat which is partly fascial and partly muscular, the cremaster muscle and fascia. Continuing its course in front of the inguinal falx, it emerges through the superficial inguinal ring, from the edges of which the external spermatic fascia is derived. Holyoke in arguing on the artificial nature of the falx inguinalis also contends that the inguinal canal is an artifact. He states the canal is produced when the cord is freed and the freeing of the cord creates a defect in the rather solid wall produced by the internal oblique and cremaster muscles and this makes special repair necessary to prevent recurrances after hernia repair. It is not within the scope of this paper to present the various techniques used for inguinal hernia repair.

The arterial blood supply to the anterior abdominal wall is derived from: the intercostal and segmental lumbar arteries; the inferior epigastric; the deep circumflex iliac; the superior epigastric and the musculophrenic artery.

The intercostal arteries of the lower two spaces enter the abdominal wall between the internal oblique and the trans-verse abdominal muscles. Anteriorly, they anastomose with

branches of the epigastric arteries; inferiorly, they communicate with the lumbar arteries. The lumbar arteries ramify similarly between the two muscles, but at a lower level in the abdominal wall. Anteriorly, they anastomose with branches of the following arteries; the inferior epigastric and intercostal arteries, above; deep circumflex iliac and iliolumbar arteries, below.

The inferior epigastric branch of the external iliac artery takes origin just above the inguinal ligament. Accompanied by two veins, at first it run medial for a short distance between the inguinal ligament and the abdominal inguinal ring. Then changing its direction, it courses superomedially on the medial side of the abdominal inguinal ring toward the lateral border of the rectus abdominis. In so doing, it forms the lateral boundary of Hesselbach's triangle. Continuing its way behind the rectus abdominis, it pierces the transversalis fascia; then, passing in front of the semicircular line, it enters the sheath of the rectus behind the muscle.. Behind the muscle it ascends vertically, and terminates in branches which perforate the rectus muscle. In the substance of the muscle, they anastomose with branches of the superior epigastric artery.

The deep circumflex iliac artery arises from the external iliac artery, near the origin of the inferior epigastric. It courses lateralward, behind the inguinal ligament, to the

anterior superior spine of the ilium. From that point onward it follows the crest of the ilium, and ends by anasto-mosing with branches of the iliolumbar artery. At first it is lodged in the extraperitoneal fat, between the transver-salis fascia and the peritoneum, in the sulcus which marks the union of the transversalis fascia and the iliac fascia. At the anterior superior spine, the artery pierces the transversus muscle about midway along the iliac crest. Its terminal twigs ramify between the transversus abdominis and the internal oblique muscles.

The superior epigastric is one of the two terminal branches of the internal mammary artery. It is situated behing the rectus muscle, and within the upper part of its sheath. The artery, unlike the inferior epigastric, quickly pierces the rectus muscle; within the substance of the latter, it anasto-moses with the inferior epigastric and the intercostal arteries.

The musculophrenic artery is the other terminal branch of the internal mammary. In the abdomen, it passes downward and lateralward along the costal origin of the diaphragm to the last intercostal space. It supplies anterior intercostal branches to the seventh, eighth, and ninth intercostal spaces. After the musculophrenic artery enters the abdomen, it gives

branches to the diaphragm, and anastomotic twigs which con-nect with similar rami of the superior epigastric and the lower two aortic intercostal arteries.

There are a number of nerves involved in the innervation of the anterior abdominal wall. The following nerves course forward between the internal oblique and the transversus abdominis muscles: anterior branches of the lower six thoracic nerves; iliohypogastric nerve and ilioinguinal nerve. The latter two are derived from the anterior ramus of the first lumbar nerve.

The anterior branches of the lower six thoracic nerves enter the abdominal wall at the border of the costal arch, where they insinuate themselves between the internal oblique and the transversus muscles. Between the costal margin and the rectus, the intercostal nerves enter into anastomotic comm-unication. Continuing medialward, the nerves run to the lateral border of the rectus muscle, where they pierce the posterior lamella of the internal oblique aponeurosis, to enter the sheath of the rectus muscle. Within the sheath they lie behind the muscle, then pierce its substance. Supplying it with twigs, the nerves continue forward to emerge through the front of the sheath. They terminate in the superficial fascia of the abdomen as the anterior cutaneous nerves. They

supply rami to the internal oblique and also to the trans-versus abdominis. In some specimens, minute arteries accom-pany the nerves; in other instances, these segmental arteries course within the substance of the parietal muscles.

The anterior branch of the last thoracic nerve also supplies the oblique and transverse muscles, and, in addition it innervates the pyramidalis muscle.

The iliohypogastric and ilioinguinal are the lowest two nerves of the series. They are directed forward, between the internal oblique and the transversus, close to the crest of the ilium.

The iliohypogastric is the higher of the two. It gives off an iliac or lateral cutaneous branch, which pierces the two oblique muscles, and then crosses the crest of the ilium to reach the skin of the gluteal region. The anterior portion of the nerve perforates the internal oblique, a short distance in front of the anterior superior spine of the ilium, and then runs forward toward the linea alba. It does not enter the sheath of the rectus, but becomes superficial by piercing the aponeurosis of the external oblique above the subcutaneous inguinal ring.

The ilioinguinal nerve gives off no lateral branch. It pierces the internal oblique, to which it gives rami, a short

distance above the inguinal ligament. It attains superficial level by passing through the subcutaneous inguinal ring.

McGregor (12) states that inguinal hernia unquestion-ably follows the McBurney muscle splitting incision in a percentage of cases; some authors put this as high as 30 per cent, but McGregor thinks this figure is much too high. A consideration of the anatomy of the incision explains this complication. The ilioinguinal and iliohypogastric nerves play a very important part in supplying those portions of the internal oblique and transversus abdominis muscles which con-stitute the falx inguinalis (conjoined tendon). This muscle mass is the most important constituent of the inguinal canal, being responsibe for the shutter action whereby the muscle descends, protecting the posterior wall of the canal, during coughing or straining. Atrophy of this muscle combination follows injury to its nerve supply, and the risk of inguinal hernia occuring is present. The iliohypogastric and ilio-inguinal nerves lie between the internal oblique and trans-versus precisely at the site of the McBurney incision, and may be damaged by cutting, retraction, or strangulation in scar tissue in septic cases. The division of the ilioinguinal nerve in hernia operations is devoid harmful effects, as the nerve is purely sensory by the time it reaches the inguinal canal.

Conclusion

Dissections of the inguinal regions of two white adult male cadavera are described. One cadaver presented the classic construction of the inguinal region as it is generally taught at the present time, it is described in detail. The other cadaver, which was picked at random, presented a stricking difference in construction. It was classic in all respects except for the inferior attachment of the internal abdominal oblique muscle, instead of attaching to the lateral portion of the inguinal ligament it was completely independent of the inguinal ligament and fused with the iliac fascia. The cre-master muscle differed in that a portion of it passed deep to the spermatic cord and attached to the iliopectineal ex-tension of the inguinal ligament.

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