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Surgical Anatomy of the Inguinal Area

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The anatomy of the inguinal region is enigmatic and confusing. Among the many structures involved in hernial repair are the iliopubic tract, the transversus abdominis aponeurosis and the transversalis fascia, the transversalis crura and sling, and the inguinal canal. There is still much disagreement among surgeons and anatomists about the existence, structure, and function of these anatomic entities.

History

> "I believe that we are but children picking up pebbles on the shore of the boundless ocean . . ." John Stephens, in *The Path Between the Seas* by David McCullough.

In reading the history of medicine—superficially, I must admit—I find it difficult to determine whom to regard as the originator of hernial surgery. Celsus is credited with this honor, but I believe that the title belongs to Heliodorus (1st Century, A.D.) and that Celsus was the reporter. As Themistocles stated: "which would you rather be—a victor in the Olympic games or the announcer of the victor?" Aulus Cornelius Celsus was the first medical writer, not a physician but a friend of physicians, *philiatros* [1]. Celsus recorded the herniorrhaphy performed by the "sun's gift," Heliodorus. During the operation, Heliodorus separated the sac from the cord, twisted off the sac, ligated the vessels, did not touch the testicles, and did not reconstruct the posterior wall of the canal. If the patient was a child (the age of the patient is not recorded), then Heliodorus did perform an almost perfect operation.

During the 7th century, A.D., Paul of Aegina stated: "One makes an incision the length of three fingers' width in the inguinal region above the swelling. One separates the skin and the fat and exposes the peritoneum and pushes aside the intestines with the tip of a sound. The bulges of the peritoneum, which are formed on two sides of the sound, are united with sutures after the sound is withdrawn; one does not cut the peritoneum or touch the testicles, but one proceeds simply to the treatment of the wound" [2]. Twelve centuries later, Halsted stated: "The operation for the medical cure of a hernia in the time of the Roman emperors was quite on a par with the operation as it is usually performed in our day. Four hundred years later, the operation had ceased to exist" [3].

We hope that, one of these days, someone will collect enough pebbles from the "boundless ocean" to present to the medical profession the correct surgical anatomy of the area and the ideal technique of repair.

Reminiscence

> "You won't get fired if you do something, you will if you don't do anything. Do something if it is wrong, for you can correct that, but there is no way to correct nothing." John Stephens in *The Path Between the Seas* by David McCollough.

The year was 1938, and I was a student at the medical school in Athens, Greece. I was working in my brother's surgical clinic, a 60-bed hospital. I had just finished studying anatomy and osteology when I began helping my brother in the operating room. On the schedule were 2 herniorrhaphies and 1 appendectomy.

My brother began to ask me questions. I remember the first one was about the innominate bones. I knew the answer—the innominate bones were the ilium, the ischium, and the pubic bones—but I did not know why they were called "innominate." The answer was, "Because Galen said they don't have their own name."

I was asked several such questions in the early hours of this hot summer day—my baptism into surgery as well as into inguinal herniorrhaphy. I was familiar, of course, with the abdominal muscles, but I also learned that morning that, again, according to Galen, the rectus abdominis muscle should be called "straight" (*euthis*).

The ligaments of Henle, Colles, Poupart, and Cooper were well known to me, but somehow the topography and overall architecture of the inguinal canal was terra incognita. At that time, surgeons thought that part of the internal oblique and

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transversus abdominis muscles originated in the inguinal ligament; that the external oblique muscle continued to the scrotum as the external spermatic fascia; and several other "small" ignorant mistakes. For some reason, we did not know that the innominate fascia is responsible for the external spermatic fascia and that the internal oblique and transversus abdominis muscles are related to the inguinal ligament only by passing at least partially under it to reach the Cooper ligament.

The operation my brother performed that morning was a typical Bassini technique: ligation and excision of the sac and reconstruction of the posterior wall of the canal by suturing the conjoined tendon and the internal oblique and transversus abdominis "muscles" to the shelving edge of the inguinal ligament just behind the cord. I never remember seeing any other type of operation; indirect and direct hernias were both treated by the same procedure.

Femoral hernias were repaired from below the inguinal ligament by purse-string sutures through the inguinal, Gimbernat, and pectineal fasciae. The Cooper ligament was not used, and the conversion of a femoral hernia to a direct hernia by an inguinal incision was not done, even though it was mentioned in the gynecology book of Logothetopoulos [4]. If I remember correctly, there were more recurrences of femoral than of inguinal hernias. All operations were performed with local anesthesia.

Another experience that I had prior to coming to the United States of America (U.S.A.) was one with the Mermingas method. Dr. K. Mermingas was Professor of Surgical Anatomy and Technique at the University of Athens Medical School. He had made an incision in the internal oblique and transversus abdominis muscles just above the internal ring, and he was fishing for the sac through this small opening. After the removal of the sac in the usual manner, Mermingas closed the defect with interrupted sutures and continued the operation with the Bassini technique. Did he want to save the sphincter action by preserving the local anatomy and integrity of the internal ring? I do not know. Mermingas' method was not popular, and I saw him perform his operation only once [5, 6].

When I came to the U.S.A., my confusion about the inguinal canal and the anatomic entities involved would continue from book to book until I read the works of McVay and others and until I started working in the anatomy laboratory at Emory University.

During my first year at Grady Memorial Hospital, Atlanta, Georgia, I witnessed the McVay procedure and the use of the Cooper ligament in the repair of direct, indirect, and femoral hernias. In this article, I will add to my reminiscences the several anatomic entities useful in hernial repair. These include the iliopubic tract, the transversus abdominis aponeurosis and the transversalis fascia, the transversalis crura and sling, and the inguinal canal. I confess that after I spent 25 years in the laboratory and after thousands of herniorrhaphies, the inguinal canal is still terra incognita to me. It may be slightly better known, but it is still enigmatic and confusing.

We have just finished writing our book, *Hernia: Surgical Anatomy and Technique*, and are still confused about some anatomic areas and entities. In some hernias, however, the anatomic areas involved are well defined and there is minimal confusion. We as scientists are seeking the facts, the most consistent patterns of structure and function, with the hope that students, residents, and practicing physicians will be as well informed as possible and be able to perform without error in the operating room.

Our purpose in this presentation is to emphasize certain anatomic structures that continue to confuse students. These anatomic structures are discussed regularly in treatises on hernia.

Selected Anatomic Structures of the Inguinal Region

> "We have immense territories to cultivate, roads to open, harbors to deepen, canals to dig, rivers to make navigable, railroads to complete." Emperor Napoleon III in *The Path Between the Seas* by David McCullough.

The Internal Oblique Muscle

Anatomists and surgeons disagree about the relation of the internal oblique muscle (Fig. 1) to other entities in the inguinal region. McVay [7] regarded the actual origin of the muscle as the iliopsoas muscle fascia. We agree with him. We observed this arrangement in fresh, thin cadavers. The internal oblique muscle could be easily separated from the inguinal ligament with the handle of a knife, and the origin of the internal oblique muscle from the iliopsoas fascia could be seen. We also agree with McVay that no muscles originate from or insert into the inguinal ligament; there are only fascial attachments.

Some disagreement also exists about the medial termination of the internal oblique muscle. Although anatomists are in accord about its participation in the anterior rectus lamina, they do not agree about the formation of the conjoined tendon, which we will discuss later.

One must remember, "None of the fibers of the internal oblique muscle have an insertion into Cooper's ligament and, therefore, do not contribute to the lower portion of the posterior inguinal wall" [7].

The Transversus Abdominis Muscle

Much of the same discussion about the origin of the internal oblique muscle in the inguinal area applies to the transversus abdominis muscle as well (Fig. 1). Rather than quoting several authors, we again voice our agreement with McVay that this muscle in the inguinal area arises from the iliopsoas fascia and not from the inguinal ligament.

The transversus abdominis arch is a useful anatomic entity for the repair of inguinal hernias. The arch is formed by the free aponeurotic and muscular margin of the muscle. Medially, the arch is aponeurotic, whereas toward the internal ring it is both muscular and aponeurotic. In the vicinity of the internal ring, the tissue is internal oblique muscle and transversus abdominis aponeurosis. The transversus abdominis muscle inserts on the Cooper ligament. Further medially in the inguinal area, all the aponeurotic layers of the 3 flat muscles pass anterior to the rectus muscle and form the anterior lamina of the sheath.

The integrity of the transversus abdominis muscle prevents the formation of a hernia. We therefore agree with McVay that, in this sense, the transversus abdominis is the most important layer of the abdominal wall.

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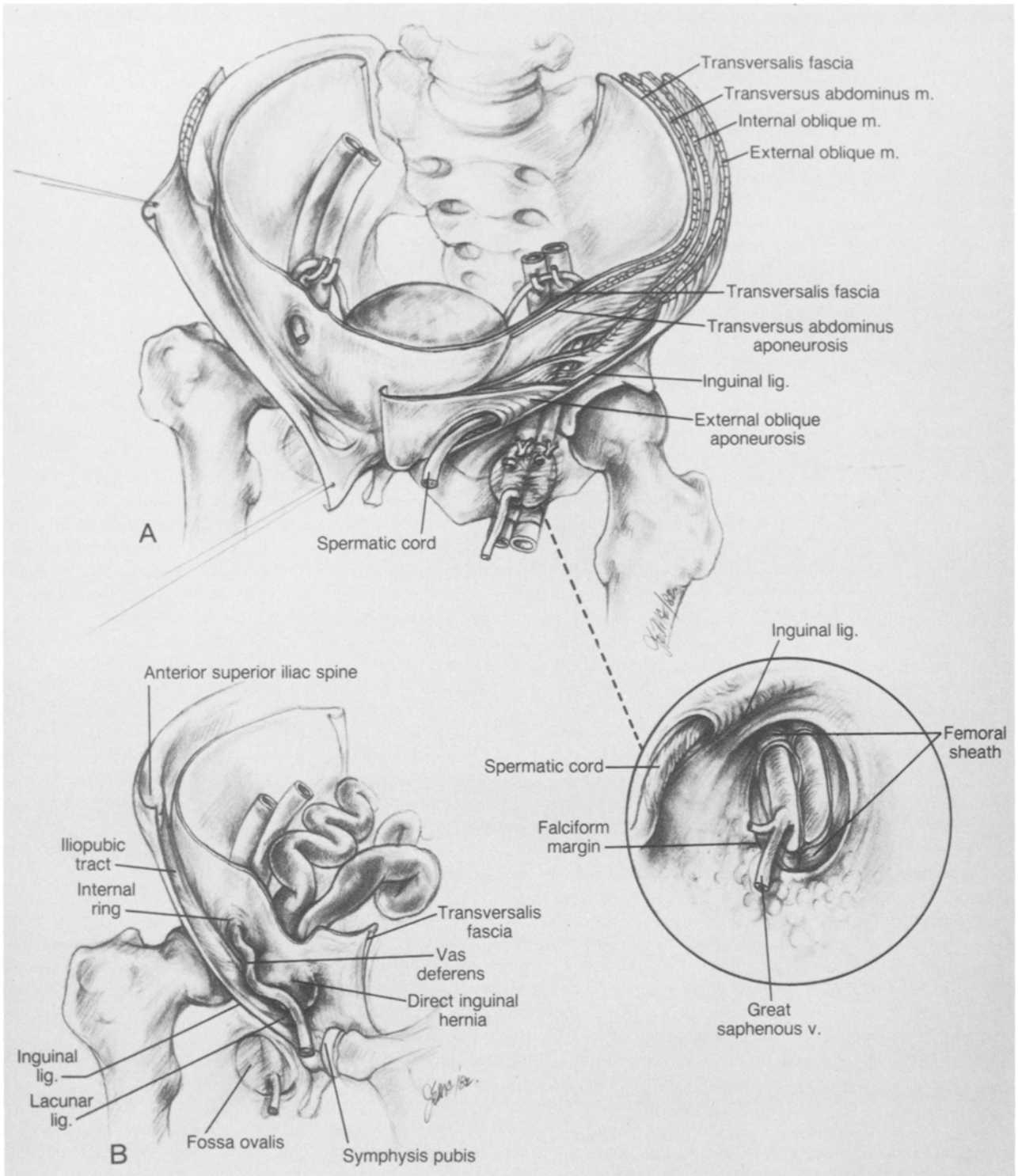

Fig. 1. Note the formation of the internal oblique and transversus abdominis muscles and their relation to the inguinal canal. Reprinted with permission of publisher [24].

The Conjoined Tendon

Buried among the names of structures real or imaginary in the inguinal region is the term *conjoined tendon*. Looking in the dictionary, one finds that anatomists decided in 1895 that the structure in question should be called the *falx inguinalis*. At the time of this decision, knowledge of inguinal anatomy was still developing. Around 1900, the term *conjoined tendon* entered the literature. The earliest use has not been found, but the term appears in the second edition of Gerrish's *Textbook of Anatomy*

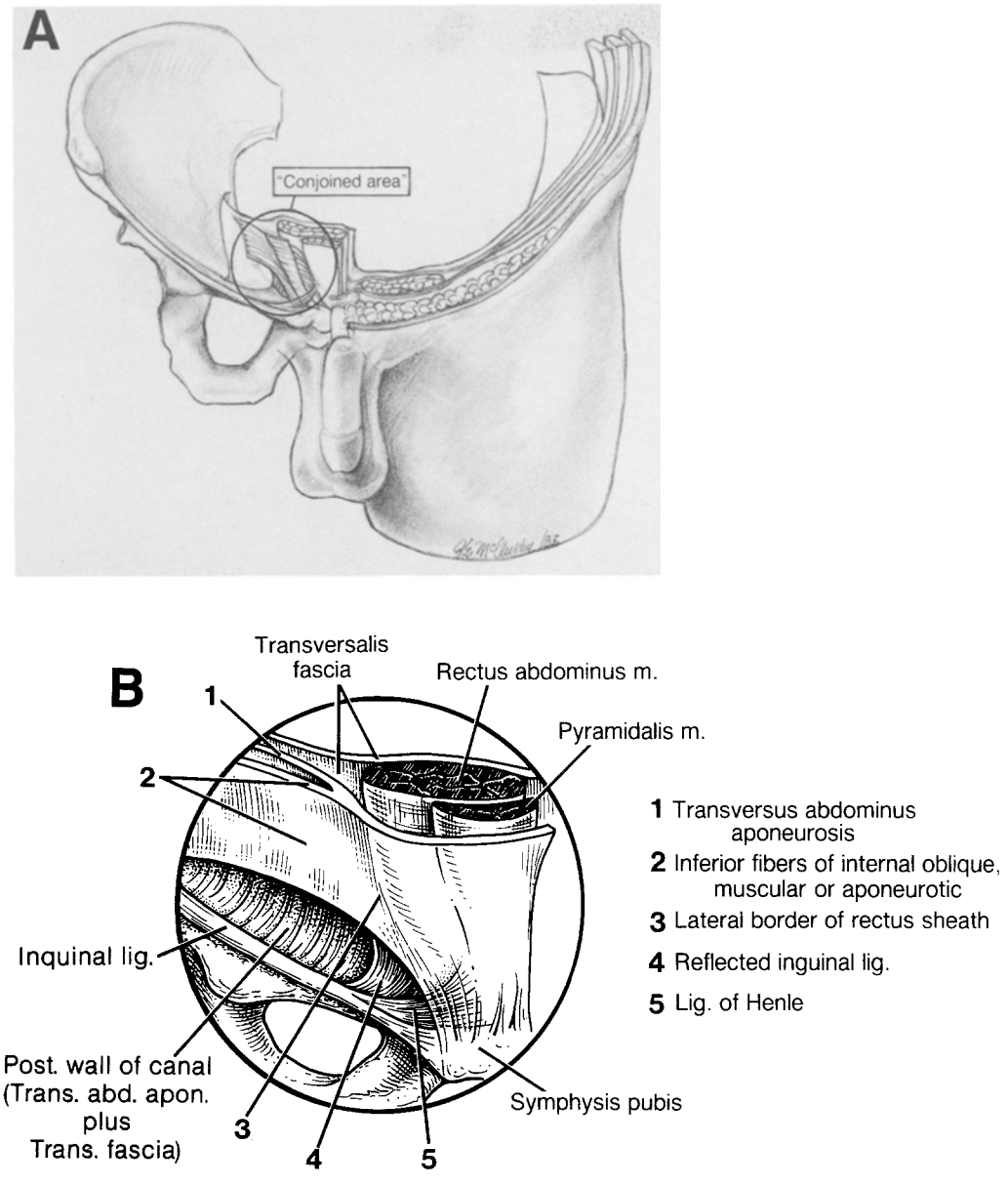

Fig. 2. The conjoined area. Reprinted with permission of publisher [24].

by American Authors [8]. The *Nomina Anatomica* in 1950 and again in 1960 admitted that usage favored *conjoined tendon* rather than *falx inguinalis* [9, 10]. It was agreed that the term *tendo conjunctivus* would be considered an official alternative.

The conjoined tendon (Fig. 2) is, by definition, the fusion of lower fibers of the internal oblique aponeurosis with similar fibers from the aponeurosis of the transversus abdominis muscle just as they insert on the pubic tubercle and superior ramus of the pubis. This description is simple and straightforward. The trouble is that the anatomic configuration described is extremely rare. Hollinshead [11] considered it to exist in only 5% of bodies. Condon [12] allows 3%. McVay [7] believed the conjoined tendon to be only an artifact of dissection.

In spite of these opinions, surgeons continue to behave as if the conjoined tendon were usually present. We looked at 100 reports of herniorrhaphies, including 7 of our own, in which it was soberly stated that the conjoined tendon was sutured to the shelving edge of the inguinal ligament or to the ligament of Cooper. During training, surgeons are taught that the conjoined tendon is there, so we must have seen it. Of course, the "Emperor is wearing new clothes."

The structures used in the operating room for the repair of an inguinal hernia are the transversus abdominis aponeurosis, the transversalis fascia, and the lateral edge of the rectus sheath. Occasionally, the internal oblique muscle, the internal oblique aponeurosis, the falx inguinalis in the original sense, the ligamentum interfoveolar, or the reflected inguinal ligament is used. None of these are conjoined, but there is a tendency among surgeons to use the term for any mass of fascia or aponeurosis from the internal oblique or the transversus abdominis muscles.

Because of the number of structures juxtaposed in this area, and because the term *conjoined tendon* is widely used, we suggest that the concept of the area of the conjoined tendon be reduced to be called the *conjoined area* (Fig. 2). The area can be easily identified by an inexperienced surgeon who understands that it is occasionally tendinous. In other words, it is the area in

which there would be a conjoined tendon if there were a conjoined tendon. We believe this system accommodates both the myth and the facts.

There are a few other definitions to make the local anatomy clearer: (1) The arch of the transversus abdominis muscle becomes less muscular and more aponeurotic as it approaches the rectus sheath. It is covered close to the internal ring by the much more muscular arch of the internal oblique muscle but is practically never covered in the lower medial portion of the inguinal region. In the inguinal region, the structures are internal oblique muscle and transversus abdominis aponeurosis; (2) The structure originally termed *falx inguinalis* is the ligament of Henle. We prefer the latter term because the falx has become confused with the conjoined tendon. The ligament of Henle is the lateral expansion of the tendon of the rectus abdominis muscle or an expansion of the rectus sheath, which inserts on the pecten of the pubis. Because this ligament is present in 30–50% of patients and is fused with the transversalis fascia, it may be seen occasionally in the surgical field, and the surgeon's needle may penetrate it once or twice in the course of a hernial repair; (3) The interfoveolar ligament (of Hesselbach) is an apparent thickening of the transversalis fascia at the medial side of the internal inguinal ring. It lies in front of the inferior epigastric vessels like a spider web. It is not a true ligament, and when it is well developed, one has the impression that it is only a lateral condensation of the ligament of Henle; (4) The reflected inguinal ligament consists of aponeurotic fibers from the inferior crus of the external inguinal ring extending medially upward toward the linea alba. French anatomists call this the *posterior crus*.

We have tried to avoid controversy concerning the nomenclature of the inguinal region, but 25 years of teaching anatomy and more than 25 years of practicing surgery makes it necessary for us to state our convictions that: (1) The conjoined tendon rarely exists; (2) The distinction between *falx inguinalis* and *conjoined tendon* is one of anatomic nicety and is admittedly of little practical importance in the operating room provided that the distinction is understood; (3) The term *conjoined area* may be applied correctly to the region that contains the ligament of Henle, the transversus abdominis aponeurosis, the inferior medial fibers of the internal oblique muscle or aponeurosis, the reflected inguinal ligament, and the lateral border of the rectus sheath.

The Transversalis Fascia

Sir Astley Cooper [13] described this fascia as follows: "When the lower portions of the internal oblique and transversalis muscles are raised from their subjacent attachments, a layer of fascia is found to be interposed between them and the peritoneum, through which the spermatic vessels emerge from the abdomen. This fascia, which I have ventured to name *fascia transversalis*, varies in density, being strong and unyielding towards the ilium, but weak and more cellular towards the pubes."

Because of their similar appearance as sheets of connective tissue, aponeuroses and fasciae may be confused terms. An *aponeurosis* is a flat tendon composed of dense, regular, collagenous connective tissue that joins a muscle to its origin or insertion.

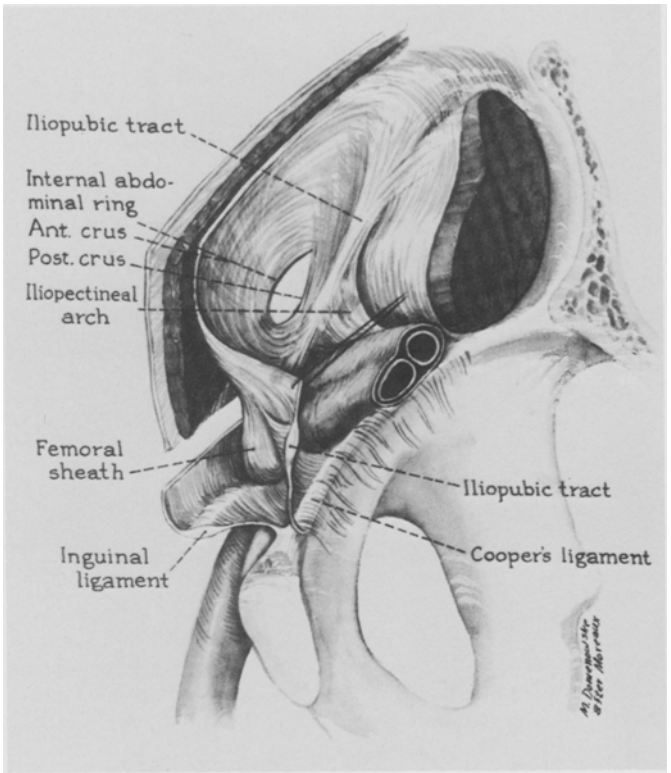

Fig. 3. The iliopectineal arch. Reprinted with permission of publisher [25].

Around each skeletal muscle, a loose-to-dense connective tissue sheath or *fascia*, the epimysium, continues over both surfaces of an aponeurosis as the epitendineum. It may or may not be thick enough to be demonstrable on gross inspection and it does not have the strength of an aponeurosis. A fascial sheet may become aponeurotic secondarily. The iliotibial tract of the thigh, consisting of deep fascia that ensheathes the aponeurotic tendons of gluteus maximus and the tensor fascia lata muscle, is an example of this point.

The inguinal canal may be thought of as a cleft between 2 major musculoaponeurotic layers. The anterior layer is formed by the external oblique aponeurosis and the innominate (Gallaudet) fascia, and the posterior layer is formed by the transversus abdominis aponeurosis, the internal oblique aponeurosis, and the transversalis fascia. It is the posterior layer that is of primary concern to a surgeon repairing the floor of the inguinal canal.

The name *transversalis fascia*, formerly applied to the deep fascia covering the internal surface of the transverse abdominis muscle, is now applied to the entire connective tissue sheet lining the musculature of the abdominal cavity. In some areas, this fascial layer is given a specific name, such as iliacus or psoas fascia, where it covers those muscles.

The transversalis fascia (Figs. 1, 2) may be thin and closely adherent, as is the portion covering the transversus abdominis aponeurosis. In other areas, it may be thick and discrete [14].

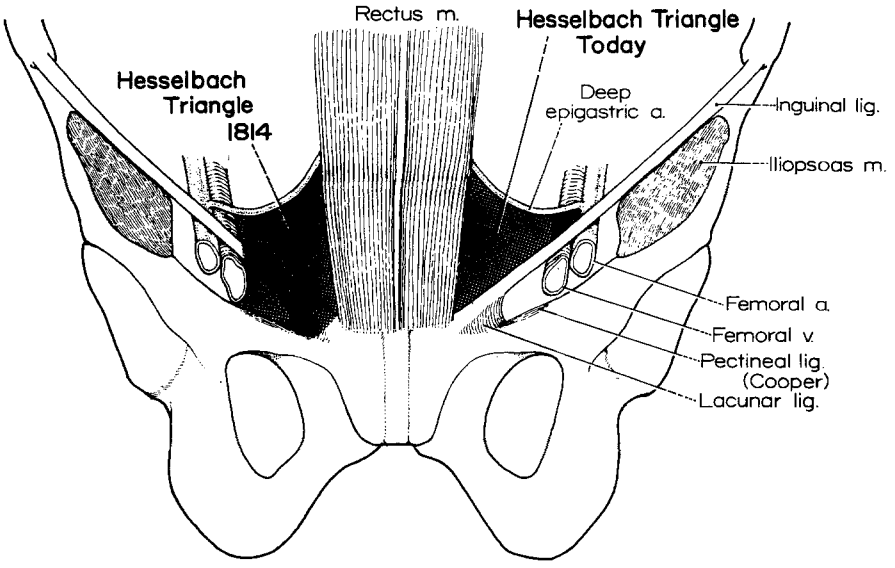

Fig. 4. The triangle of Hesselbach. Reprinted with permission of publisher [14].

The Iliopectineal Arch

The iliopectineal arch (Fig. 3) is a medial thickening of the iliac fascia; it covers the iliacus muscle where the muscle leaves the pelvis. The arch attaches laterally to the anterosuperior iliac spine and medially to the iliopectineal eminence. A surgeon never uses this fascia directly, but it is important as a common site of junction of a number of structures of the lateral groin. These are: (1) the insertion of fibers of the external oblique aponeurosis (fibers of the inguinal ligament), (2) the origin of part of the internal oblique muscle, (3) the origin of part of the transversus abdominis muscle, and (4) the lateral attachment of the iliopubic tract (it contributes also to the lateral wall of the femoral sheath).

The Iliopubic Tract

The iliopubic tract (Fig. 3) is an aponeurotic band that extends from the iliopectineal arch to the superior ramus of the pubis. It forms the inferior margin of the deep musculoaponeurotic layer made up of the transversus abdominis muscle and aponeurosis and the transversalis fascia.

Laterally, the tract is attached to the iliacus and psoas fascia and continues laterally to the anterior superior spine of the ilium. It passes medially to form the lower border of the internal inguinal ring, crossing the femoral vessels to form the anterior margin of the femoral sheath and composing part of the transversalis fascia. The tract curves around the medial surface of the femoral sheath to attach to the pectineal ligament. Condon [12] found the iliopubic tract present in 98% of dissections. He pointed out that it has been frequently confused with the inguinal ligament, which, although nearby, belongs to the superficial musculoaponeurotic layer; the iliopubic tract is part of the deep layer.

The Hesselbach Triangle

The Hesselbach triangle (Fig. 4) is defined today as having the inferior (deep) epigastric vessels as its superior border, the rectus sheath as its medial border, and the inguinal ligament as its lateroinferior border. This triangle is smaller than the one originally described by Hesselbach in 1814.

This triangle is the area in which most direct inguinal hernias occur. Only the medial border is suitable for hernial repair. The epigastric vessels above cannot be used, and most surgeons prefer to use the iliopubic tract or the pectineal ligament rather than the inguinal ligament [14].

Falx Inguinalis (Henle)

The falx inguinalis is a lateral vertical expansion of the rectus sheath that inserts on the pecten of the pubis and the pectineal ligament. It fuses with the transversus abdominis aponeurosis and the transversalis fascia.

The Cooper Ligament

In 1804 and 1807, Cooper described this "ligament." What is the ligament of Cooper? The following notes may help the reader understand this anatomic entity: (1) According to Nyhus and Bombeck [15], the periosteum of the pelvis . . . is intimately fused with another condensation of the transversalis fascia and iliopubic tract to form the Cooper ligament; (2) According to Hollinshead [11], the Cooper ligament is sometimes described simply as a lateral continuation of the lacunar ligament; (3) According to Condon [12], the Cooper ligament is the periosteum of the superior ramus of the pubis strongly reinforced by endoabdominal fascia (transversalis fascia) with more reinforcing by the transversus abdominis aponeurosis and the iliopubic tract medially; (4) According to McVay [16], the ligament is the periosteum of the superior ramus of the pubis lateral to the pubic tubercle where the inferior aponeurosis of the transversus abdominis is inserted. Therefore, the Cooper ligament is: an extension for the lacunar ligament and, hence, an element of the attachment of the aponeurosis of the external oblique muscle, a fascial thickening of the posterior wall of the canal where it is attached to the periosteum of the superior ramus of the pubis, a thickening of the origin of the pectineus muscle fascia.

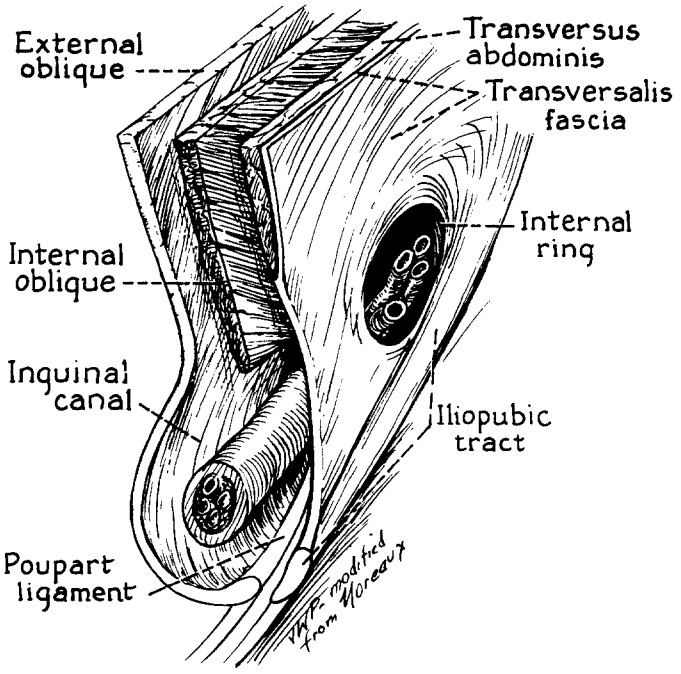

Fig. 5. Parasagittal section through the right midinguinal region, illustrating the separation of the musculoaponeurotic lamina into the anterior and posterior inguinal walls. Reprinted with permission of publisher [12].

Do we anatomists and surgeons ask for greater precision than is reasonable? Is the word *ligament* the correct one? If this is the periosteum, then the "ligament" is the reinforcement by thick fibrous tissue of several anatomic entities. How is one to consider the concept that the Cooper ligament belongs to the external oblique aponeurosis complex? Does modern philosophy about the anterior and posterior laminae of the abdominal wall and inguinal canal, and therefore the repair of inguinal hernias, need to change (Fig. 5)? I doubt it.

One thing is certain, the Cooper ligament is always there to be used if a surgeon decides to use it, ligament or not. Our experience has proved that the Cooper ligament includes: (1) fibers of origin of pectineus muscle, the pull of which probably assists in the formation of the ridge of bone; (2) periosteum; (3) fibers from insertion of the lacunar ligament; (4) fibers from insertion of the transversus abdominis aponeurosis; (5) fibers from insertion of rectus tendon (sometimes); and (6) fibers from insertion of the internal oblique muscle (sometimes) and usually limited to a centimeter or less of the pectineal ligament.

The Inguinal Canal

Boundaries. The anterior wall of the inguinal canal (Fig. 5) is formed by the aponeurosis of the external oblique muscle and, laterally, the internal oblique muscle. (The internal oblique muscle in the inguinal area is muscular, not aponeurotic.) The posterior wall is the most important wall of the inguinal canal from both anatomic and surgical standpoints. It is formed primarily by fusion of the aponeurosis of the transversus abdominis muscle and the transversalis fascia in three-fourths of persons and in the remaining one-fourth by the transversalis fascia only. The superior wall is formed by the internal oblique and transversus abdominis muscles and aponeuroses. The inferior wall comprises the inguinal and lacunar ligaments.

Important points to remember are: (1) In the inguinal area, the transversus abdominis is aponeurotic and forms 2 parts of the inguinal canal—the posterior wall of the canal (together with the transversalis fascia) and the transversus abdominis arch; (2) The external spermatic fascia is formed by the fascia of the external oblique muscle (innominate fascia of Gallaudet); (3) The internal oblique (and, to a much lesser degree, the transversus abdominis) muscle forms the cremasteric muscle of the spermatic cord; (4) The internal spermatic fascia is formed by the transversalis fascia. The arch begins lateral to the rectus sheath. It is formed by the transversus abdominis aponeurosis which, in many persons, is fused with the internal oblique muscle, and ends at the internal inguinal ring, crossing over the spermatic cord.

Physiology. Students of the physiology of the inguinal canal should examine the normal inguinal canal as well as the canal with congenital defects. Two mechanisms are responsible for the integrity of a normal canal: (1) the sphincteric action of the transversus abdominis and internal oblique muscles at the internal ring, and (2) the shutter action of the transversus abdominis aponeurosis, which forms the transversus abdominis arch.

In sphincteric action, the transversalis fascia forms a sling around the internal ring, an incomplete ring consisting of a thickening forming 2 crura—a long anterior crus and a short posterior crus. Characteristically, the anterior crus is fixed to the transversus abdominis muscle or aponeurosis above and to the internal ring medially. The posterior crus is fixed to, or inserts on, the iliopubic tract. This arrangement forms an inverted U-shaped sling. By contraction of the transversus abdominis muscle, the sling closes the internal ring under the muscular edge of the internal oblique muscle.

In shutter action, when the transversus abdominis and the internal oblique muscles contract together, the "arch" formed by the aponeurosis of the transversus abdominis muscle moves laterally toward the iliopubic tract and the inguinal ligament. By this action, the posterior wall of the canal is reinforced. If the arch does not reach the area of the inguinal ligament, the patient is subject to herniation in any part of the inguinal or femoral area.

A deficient posterior wall, found in 23–25% of persons, lacks the support of the aponeurosis of the transversus abdominis muscle. Therefore, the transversalis fascia is the only anatomic entity contributing to the continuity of the floor [17]. A highly situated arch or poor arch participation in the posterior walls and floor contributes to potential structural weakness. In a few patients we have been unable to locate the transversalis fascial crura because they were apparently underdeveloped. We do not have any statistical data to present, but we suggest that this situation be considered as a congenital defect or variation.

Surgical Considerations. The following should be considered: (1) One should approximate the crura of the transversalis fascia; (2) One should not use the inguinal ligament for repair of hernia at the area of the internal inguinal ring. Such a procedure eliminates the sphincteric action of the transversus abdominis muscle; (3) If the posterior wall is defective or the arch is

Table 1. Summary of anatomic complications of operations on groin hernias and the scrotum.

Procedure	Vascular injury	Nerve injury	Organic injury	Inadequate procedure
Indirect inguinal hernial repair	Hemorrhage or hematoma: inferior epigastric artery, exterior iliac artery, vessels of spermatic cord, femoral vein; ischemia: exterior iliac artery	Iliohypogastric nerve, ilioinguinal nerve, genitofemoral nerve	Ductus deferens, spermatic cord loop of small or large intestine: perforation, risks associated with resection	Failure to resect nonviable intestine, failure to recognize other hernias
Direct inguinal repair	As above	As above	As above	–
Femoral hernial repair	As above, aberrant obturator artery	–	Urinary bladder	–
Hydrocelectomy	Bleeding from cut edge of tunica vaginalis	–	Skin necrosis from pressure bandage	–
Varicocelectomy	Testicular artery	As above	–	Persistence or recurrence of varicosities
Epididymectomy	Injury to testicular artery	–	Atrophy of testis	Spontaneous restoration of lumen of ductus deferens; leakage of sperm (sperm granuloma)
Orchiopexy	Injury to vessels from excessive tension on spermatic cord	–	Atrophy of testis	–

displaced medially, one should use a relaxing incision or prosthesis for repair of a hernia; (4) In 1972, Wagh and Read [18] were, perhaps, the first to study the relation between collagen synthesis and inguinal hernia.

Peacock and Madden [19, 20], in 2 later publications, presented opinions about the local surgical biology of patients with hernias, emphasizing metabolic connective tissue abnormalities. They stated that a hernia is the result of an imbalance between normal collagen synthesis and normal collagen degradation.

Berliner [21] took biopsy specimens from the transversalis fascia close to the internal ring, at the site of direct hernias, and of normal transversus abdominis aponeurosis superior to the bulge of a direct hernia. He concluded that wound healing requires a fibroblastic response and an adequate supply of oxygen to irritate an ongoing balance of collagen synthesis and enzymatic lysis. An incision into the posterior wall of the inguinal canal and repair without tension is necessary to stimulate fibroplasia where it will be useful. Sutures under tension stimulate an inadequate fibroblastic response.

The Femoral Sheath and the Femoral Canal

The femoral sheath is formed anteriorly and medially by the transversalis fascia, posteriorly by the pectineus and psoas fasciae, and laterally by the iliacus fascia. The most medial of the 3 compartments of the sheath is the femoral canal, through which a femoral hernia may pass.

The femoral canal is conical, about 1.25–2 cm long. Its apex is at the fossa ovalis, the opening for the great saphenous vein. Thus, a femoral hernia may present as a bulge of the skin over the fossa ovalis.

The femoral ring is relatively rigid. McVay [16] stated that the transverse diameter ranges from 8 to 27 mm, 70% being between 10 and 14 mm. The anteroposterior diameter ranges from 9 to 19 mm, 70% being between 12 and 16 mm. The lateral boundaries are the femoral vein and connective tissue; the posterior boundary is the pectineal ligament (Cooper); the anterior boundary is the iliopubic tract or inguinal ligament or both; and the medial boundaries are the transversalis fascia, the aponeurotic insertion of the transversus abdominis muscle and, more medially, the lacunar ligament.

McVay [16] found the lacunar ligament at the medial margin of the femoral ring in only 8 of 362 persons. He considered the aponeurosis of the transversus abdominis muscle to be the usual boundary. Condon [22] believes that either the aponeurosis or the recurved iliopubic tract may form the medial boundary.

The canal usually contains areolar connective tissue, lymph nodes, and lymphatic channels. A large node is often present at the upper end of the canal [23]. This is the Cloquet node to the French and the Rosenmueller node to the Germans. The base of the canal is closed by a tenuous fatty tissue, the septum femorale [14].

Anatomic Complications

It is not within the scope of this article to discuss surgical procedures on the inguinal area and the scrotum, but for completion of the surgical anatomy of the area, we present in Table 1 some anatomic complications involved in operations on the inguinal and scrotal regions.

We have highlighted a number of anatomic structures that have always been the subject of controversy. It is the reader's challenge to decide if we have exacerbated or eased the controversy.

Résumé

L'anatomie de la région inguinale est énigmatique et trompeuse. Les structures impliqueées dans la réparation herniaire sont la

bandelette iliopubienne de Thomsen, l'aponévrose et le fascia transversalis, les piliers en fronde de l'orifice inguinal superficiel, et le canal inguinal. Chirurgiens et anatomistes continuent à discuter la réalité, la structure, et la fonction de ces entités anatomiques.

Resumen

La anatomía de la región inguinal aparece enigmática y causa confusión. Entre las numerosas estructuras involucradas en la reparación herniaria están el tracto iliopúbico, la aponeurosis del músculo transverso del abdomen y la fascia transversalis, la crura y hamaca transversalis, y el canal inguinal. Existe todavía amplia discrepancia entre cirujanos y anatomistas sobre la existencia, estructura, y función de estas entidades anatómicas.

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