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Anatomical observations on 30 cadavers: new insights into the relationship between the posterior wall of the inguinal canal and the cremaster

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Abstract

Purpose Clarify the composition of the Posterior wall of the Inguinal Canal(PWIC), the location and composition of the Transverse Fascia(TF), and the tissue origin of the Cremaster(C) by observing the anatomy of the inguinal region of the cadaver.

Methods 30 cadavers were dissected to observe the alignment of the muscles and fascia of the inguinal canal and the anterior peritoneal space. the anatomical levels of the posterior wall of the inguinal canal and the alignment of the Spermatic Cord(SC) were observed.

Results (1) The posterior wall of the inguinal canal was white, bright, and tough tendon membrane-like tissue; (2) the transverse fascia was a thin fascial tissue with only one layer of membranous structure located in the abdominal wall under the abdominal wall on the side of the blood vessels of the peritoneal cavity; (3) the internal oblique muscle and its tendon membrane, and the transversus abdominis muscle and its tendon membrane extended on the surface of the spermatic cord, and fused and continued to the cremaster on the surface of the spermatic cord.

Conclusions 1. PWIC is mainly composed of Internal oblique muscle of abdomen (IOMA), Aponeurosis of internal oblique muscle of abdomen (AIOMA), Transverse abdominal muscle (TAM), and Transverse abdominal aponeurosis(TAA) as the following four types: (1) TAM and AIOMA fused to form a tendinous layer; (2) IOMA and TAM form the posterior wall of the muscle in the PWIC; (3) IOMA and AIOMA continue in the PWIC; 4) TAM and TAA continue in the PWIC. 2.TF is a thin fascial tissue with only one layer of membrane structure, TF is not involved in the composition of PWIC, so this fascia has nothing to do with resisting the occurrence of inguinal hernia. 3. The spermatic cord that travels in the inguinal canal is fixed to the lower wall of the inguinal canal by the tendon membrane of the cremaster, which is organized from the internal oblique and transversus abdominis muscles and their tendon membranes, The inguinal canal is a musculotendinous canal.

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Keywords Transverse fascia, Posterior wall of the inguinal canal, Aponeurosis of internal oblique muscle of abdomen, Cremaster

Introduction

Inguinal hernia is common disease in general surgery, the first occurrence of unilateral inguinal hernia accounted for 75% of the abdominal wall hernia; inguinal hernia occurs more often in males than females, the right side is more common than the left side; The prevalence rate for male is 27%, for female it is 3% [1–3]; Direct inguinal hernia, Indirect inguinal hernia and femoral hernia are caused by weakness of the transversus fascia(TF) of the Myopectineal Orifice [4, 5]. Most scholars now believe that the PWIC consists of the TF and is a direct barrier against hernia. In inguinal hernia repair surgery, the reinforcement and suturing of the TF is the main focus of surgery. However, most scholars believe that it is the thickened TF and iliopubic tract that have the effect of strengthening the Posterior wall of inguinal canal(PWIC) to prevent Herniation of hernia contents. In recent years, the role of the TF in preventing the occurrence of inguinal hernia has been questioned. Clarification of the anatomical levels of PWIC can help to improve hernia repair surgery and reduce the recurrence rate after hernia surgery.

The tendon membrane is attached to the surface of the muscle and wraps around the surface and back of the muscle, so the tendon membrane is a continuation and fusion of the myofascial tissue on the surface of the two layers of muscle; the tendon membrane is the tendon of the flattened muscle, which is flat, wide, membranous, and a dense connective tissue, while Fascia is a loose connective tissue that does not continue into the tendon and muscle sheath [6].

Materials and methods

The entire study was conducted in strict accordance with the protocol approved by the Biomedical Ethics Committee of Xi'an Jiaotong University (Ethics License No. 2014−0303). Thirty formalin-fixed adult cadavers (20 males and 10 females) were provided by the Department of Human Anatomy and Histoembryology, School of Medicine, Xi'an Jiaotong University. Dissections were performed by two experienced hernia surgeons in our department, and the inguinal region of the cadavers was dissected according to the same method. Commonly used surgical instruments (tissue clips, scalpels, scissors) were used to avoid complex visualization techniques. The format of the informed consent form was in accordance with the guidelines of the China Organ Donation Management Center.

Methods

An oblique incision was made along the inguinal ligament, and the bilateral inguinal region was dissected, and the skin and superficial fascia were separated layer by layer anatomically, and the Aponeurosis of external oblique muscle of abdomen(AEOMA) was separated along the medial border, so that the inguinal canal was exposed, and the tissues in the posterior wall of the inguinal canal were observed.

The posterior wall of the inguinal canal is incised in the sagittal direction, and the AIOMA, TAM and its tendon membrane are seen to extend downward in the inguinal canal. Dissecting the inguinal canal to the internal ring, the inferior wall of the spermatic cord is seen to be adhered closely to the inferior wall of the inguinal canal with tough tissue, which is difficult to detach bluntly. The spermatic cord extends along the inguinal canal to the scrotum and forms a "Y" shape with the lower wall of the inguinal canal (inguinal ligament). Probing the posterior wall of the inguinal canal, the tissue of the posterior wall was seen to be tendon membrane-like, with a tough texture and non-fascial loose connective tissue, and the tendon tissue of the posterior wall was separated layer by layer to observe the nature of the tissues of the various layers and their alignment, and the above were photographed and recorded (Fig. 1).

Results

The PWIC in all 30 cadavers (20 males and 10 females) was tough tissue, the PWIC continued to the pubic symphysis, with the inguinal ligament and iliopubic tract continuing to the pelvis, the fascial tissue located dorsal to the inferior abdominal wall artery, which is the true TF, the PWIC is a tendon membrane tissue, there is no fascial tissue, and the TF is not involved in the composition of the PWIC.

A layer of firm fibrous connective tissue posterior to the spermatic cord or round ligament of the uterus, which is medial to the inferior epigastric artery; this layer of fibrous connective tissue is therefore the PWIC, which has a strength similar to that of tendon membranes (Fig. 2), and it was distinctly different from the TF strength. In most specimens, the posterior wall of the inguinal canal showed brighter, whiter, and tougher tenosynovial tissue, which was continued as AIOMA and TAA, and these two layers of tenosynovial membrane were continued in the posterior wall of the inguinal cannal, and at the termination of the IOMA and TAM, they were divided into two layers to encircle the IOMA and TAA.The surface muscle membranes of IOMA and TAM

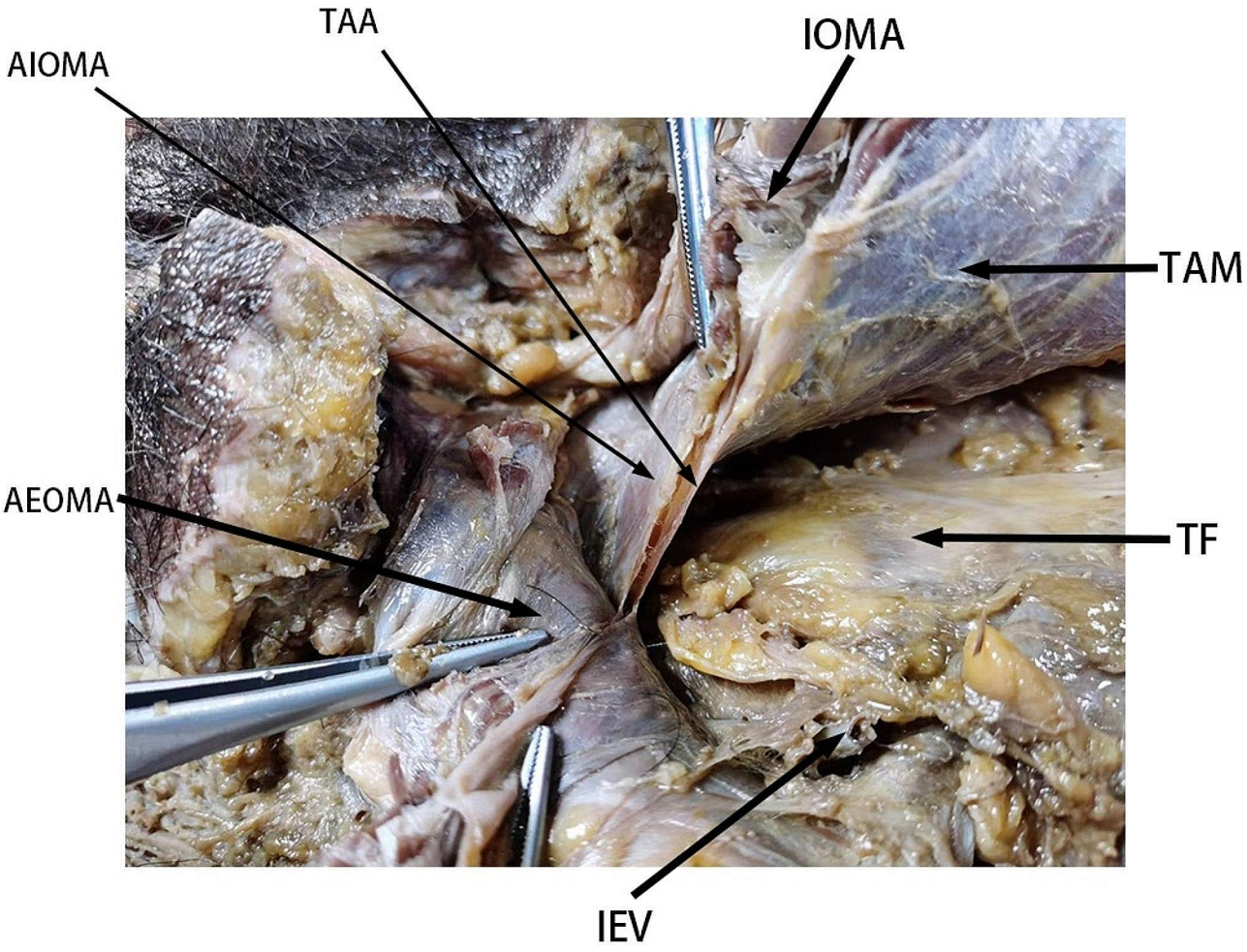

Fig. 1 Aponeurosis-like tissue of PWIC can be seen after transection of IOMA and TAM

fuse tough aponeurosis like tissue in a "Y" shape towards the pubic symphysis, forming PWIC (Fig. 3a, b and c).

Existing anatomy	Our Findings	Actual significance
Posterior wall of the Inguinal Canal(PWIC)	PWIC is mainly composed of four types: 1) TAM and AIOMA fused to form a tendinous layer; 2) IOMA and TAM form the posterior wall of the muscle in the PWIC; 3) IOMA and AIOMA continue in the PWIC; 4) TAM and TAA continue in the PWIC	The tenosynovial tissue of PWIC consists of AEOMA and AIOMA, which run parallel to each other, and this type of population has a low risk of hernia; the other type is staggered, in which the PWIC is only one layer of tenosynovial tissue, and the area where the two layers of the PWIC cross becomes a weak area, which is prone to inguinal hernia.
Transverse Fascia(TF)	TF is a thin fascial tissue with only one layer of membrane structure, TF is not involved in the composition of PWIC	sharp separation is required when surgically freeing the spermatic cord, and that separating the spermatic cord at the inferior margin of the arcuate margin of the inguinal canal is the safest, easy to recognize and separate, and avoids damage to the spermatic cord.
Spermatic Cord(SC)	The spermatic cord that travels in the inguinal canal is fixed to the lower wall of the inguinal canal by the tendon membrane of the cremaster, which is organized from the internal oblique and transversus abdominis muscles and their tendon membranes, The inguinal canal is a musculotendinous canal.	

Discussion

Inguinal hernia surgery has achieved good surgical results by repairing or reinforcing the PWIC; before Lichtenstein repair (tension-free repair), Bassini reconstructed

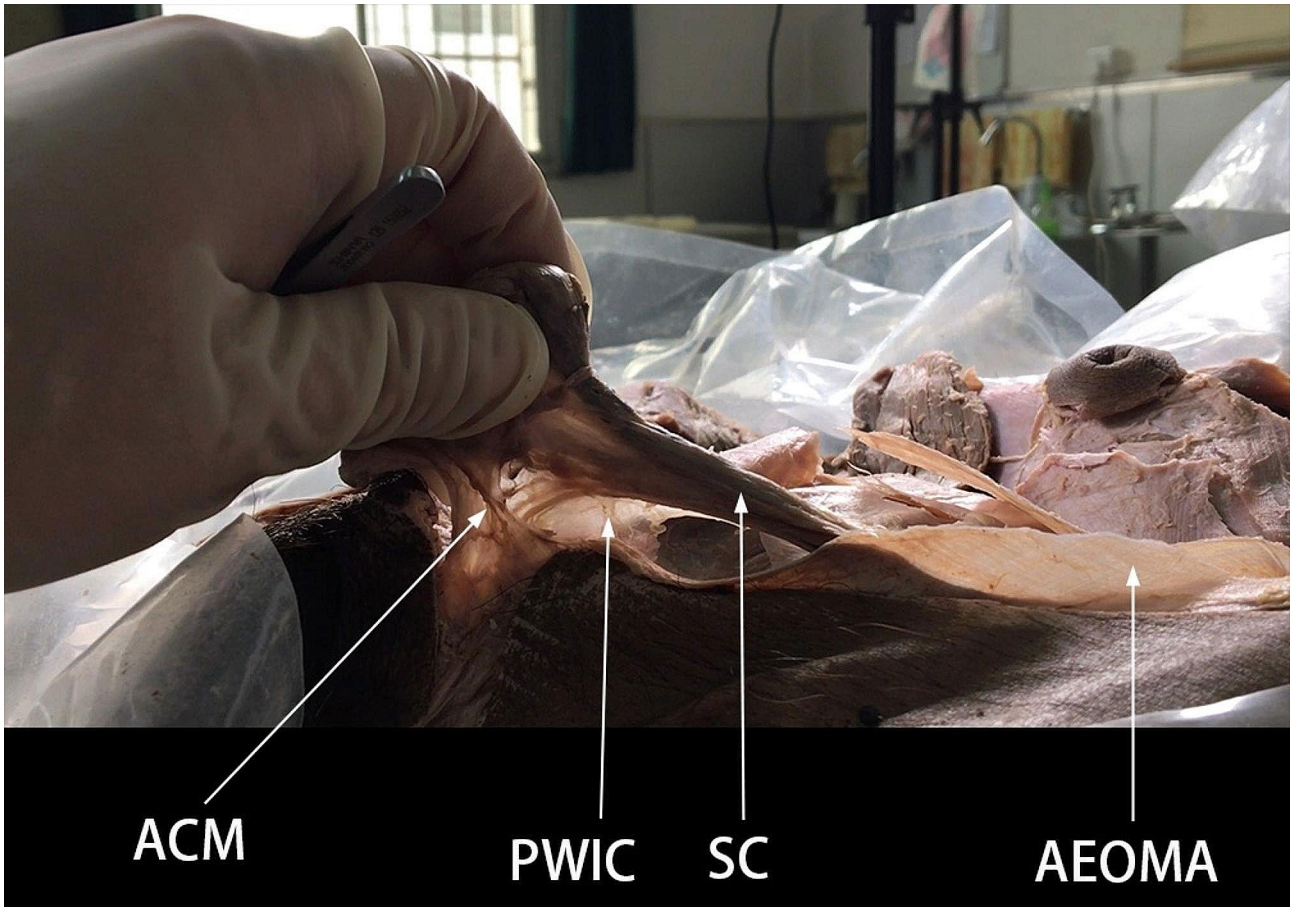

Fig. 2 PWIC is a transparent, tough aponeurotic tissue

and reinforced the PWIC by suturing the IOMA and TF to the inguinal ligament and iliopubic tract; the Shouldice method overlapped the tissues of the Bassini method in four layers and then sutured them together ; the McVay repair method sutures the TF, conjoint tendon and pubic comb ligament together [7]; scholars generally agree that the posterior wall of the inguinal canal is the TF, and the most important structure in the operation is the transverse fascia, which is the key to the success or failure of inguinal hernia surgery.

Most scholars now believe that the PWIC consists of the TF and is a direct barrier against hernia. However, the transverse fascia located in the inguinal region is very thin and difficult to recognize, it is easy to confuse the transverse fascia with other fascial tissues; Skandalakis believe that TAA and TF form the PWIC [8]. Pierpont found that the transversus abdominis muscle fibers in the inguinal region were fixed to the TF and could not be separated [9], Colborn and Skandalakis hypothesized that the transversus abdominis muscle emerges in its tendon membrane, which together with the tendon membrane of the internal oblique muscle forms the anterior layer of the TF [10].

As we know, The tendon membrane is attached to the surface of the muscle and wraps around the surface and back of the muscle, so the tendon membrane is a continuation and fusion of the myofascial tissue on the surface of the two layers of muscle; the tendon membrane is the tendon of the flattened muscle, which is flat, wide, membranous, and a dense connective tissue, while Fascia is a loose connective tissue that does not continue into the tendon and muscle sheath [10].

Condon's study showed that TF constitutes PWIC, which is layer of weak textured fascial tissue, and that only 20% of people have TF strength that meets the requirements for suture strength in inguinal hernia repairs [11].

Barry, Irving L, and Lichtenstein all agree that the transverse fascia is lax connective tissue, usually only one cell thick, and that this tissue wraps around all the muscle layers and the tendon layer but lacks the organization and strength of the tendon membrane, and is of questionable value as a support layer for hernia repairs.Jiro Ohsawa states that at the time of a hernia repair surgery, it is not only the PWIC that is reinforced with the TF, but also the TAA iliopubic tract and Cooper's ligament [12].

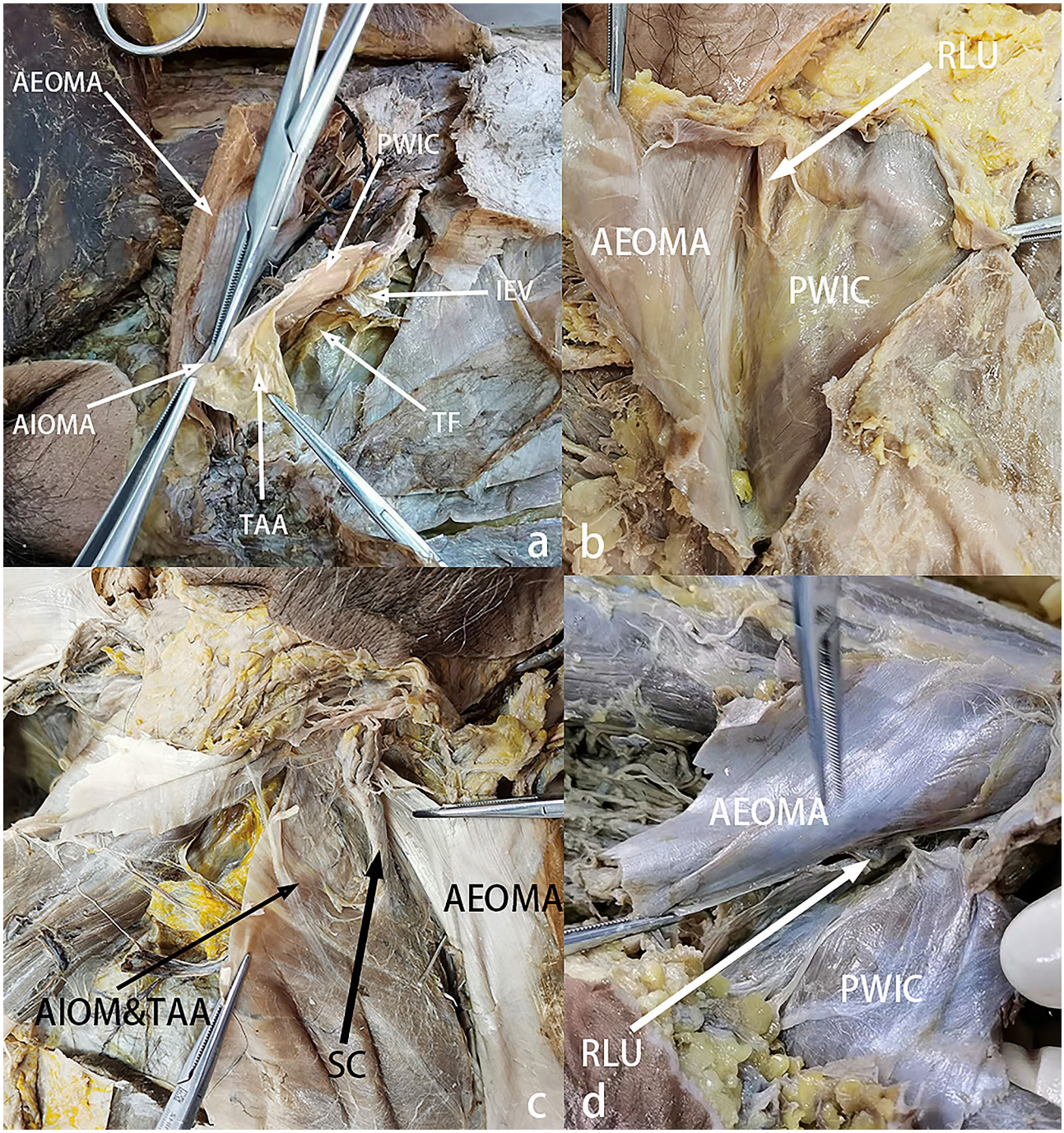

Fig. 3 **a**: PWIC is composed of AIOMA&TAA. **b**: PWIC of a female specimen. **c**: male specimen: PWIC is aponeurotic tissue. **d**: PWIC of a female specimen consists of two layers of muscle tissue up to the pubic symphysis

In a female cadaveric specimen, the PWIC was continued from the muscle up to the pubic symphysis, and four layers of myofascial tissue were present in the posterior wall, and further dissection confirmed that the muscles in this area were IOMA and TAM. (Fig. 3d)

In a male specimen, the TAM in the inguinal region was free from the PWIC, and the TAA stopped at the stopping point of the TAM and did not fuse with the internal oblique abdominal muscle (IOMA) and the tendon membrane of the posterior wall; the posterior wall of the specimen consisted of the IOMA and the tendon membrane only

We found that the anatomy of the posterior wall of the inguinal canal in the three male cadaveric specimens differed from the conventional anatomical level. In two specimens, the anterior wall of the inguinal canal consisted of the EOMA and the IOMA and its tendinous membrane, the spermatic cord traveled in the inguinal canal, only the TAM and its tendinous membrane existed in the posterior wall of the inguinal canal (Fig. 4a, b, c and d). In another specimen, the IOMA stops at the Arcuate margin, the AIOMA does not extend downward, and the posterior wall of the inguinal canal is TAA (Fig. 5)

Fig. 4 **a**: AIOMA of the male specimen is located on the upper side of the spermatic cord. **b**: PWIC is TAM and its aponeurosis. **c**: After opening the AIOMA, the anatomy of the inguinal canal in this male specimen indicates that the PWIC is TAM and its aponeurosis. **d**: The AIOMA of the male specimen in this case stops at the position of the arcuate margin and is not involved in the formation of the PWIC

T.Wolloscheck et al. tested the strength of the transverse fascia, The result showed that comparing to AIOMA and AEOMA, TF had the lowest mechanical stability [13]. They concluded that simply reinforce the weak TF has a limited contribution to increasing the strength of the PWIC. This is theoretically contrary to the treatment of hernia by suturing or reinforcing the thin TF during surgery, but in actual surgery, suturing or even reinforcing the PWIC is highly effective in treating inguinal hernia.

Prof. Cooper believes that the PWIC is overlain by the IOMA, TAM [14] In autopsy we find that the PWIC tissue more closely resembles the toughness and strength of the tendon membrane, and that the muscular membrane of the internal oblique muscle and the transversus abdominis muscle extend downward from the anterior and posterior surfaces of the muscle and merge into a layer that stops at the inguinal ligament. The TF in the inguinal region is recognized in Formal Anatomy as being very dense with TAA reinforcement [15]. Irving L. Lichtenstein suggests that the fascia is not strong enough and that the inguinal tensor fasciae latae is the attachment point for the three flat tendons of the abdominal wall [4]. The tendons are so strong that only the tendons and not the fascia should be used in hernia repair.

Bendavid and Howarth studied the structure of the PWIC histologically and found that the posterior wall tendon membrane contains muscle fibers that extend to the base of the inguinal ligament. The histology showed that (1) the TAA layer was thicker while the TF was thinner, and loose connective tissue was found to be located between the AIOMA, TAA, and TF. (2) Microscopic magnification of the same part of the same structure taken in 1) revealed that the cell density of the TF was more pronounced than that of the AIOMA and TAA. (3) A clear demarcation can be observed under the microscope between the above three membranous tissues, and a muscle tendon membrane transition [16];

McVay [17]. found that in the inguinal region TAA fuses with TF to form a fusion fascia. In contrast, in a

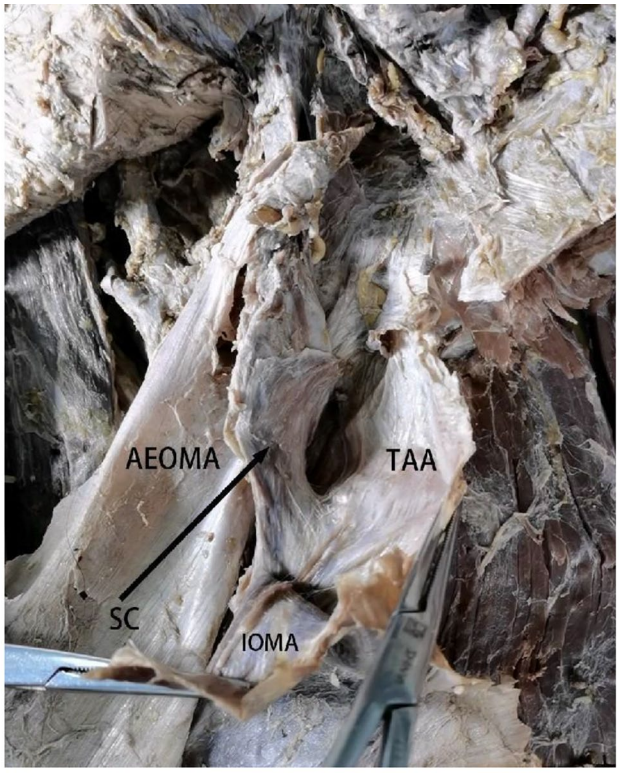

Fig. 5 After AIOMA is opened, the PWIC of this sample is TAA

In summary, our anatomical study of the inguinal canal by specimen dissection revealed that the PWIC was mainly composed of IOMA, AIOMA, TAM, and TAA as the following four types:1) the tendinous layer formed by the fusion of TAM and AIOMA (83.33%) (Fig. 6a); 2) TAM and TAA (10%) (Fig. 6b);3) IOMA and AIOMA in PWIC continuation (3.33%) (Fig. 6c); 4) the IOMA and TAM formed the posterior wall of the muscle of the PWIC (3.33%) (Figu. 6d);

study of 500 cadavers, Anson [18] found that the IOMA extended into the inguinal canal in only 2% of the specimens and that muscle tissue was present in the inguinal canal; in 75% of the specimens, the muscle of the IOMA covered only about 75% of the inguinal canal region, and the remaining area was covered by the AIOMA.Chandler and Schadewald [10] found that the IOMA completely covered the inguinal region in only 21.0% of the specimens, and that the area not covered by IOMA extended out to be covered by the AIOMA, and that the IOMA was followed deeper by the TAM, which also covered the inguinal region.The IOMA covered at least half of the inguinal region in 46.0% of the specimens, while it failed to cover the inguinal region completely in 32.8% of the specimens. This is contrary to the theory that the anatomical composition of the PWIC is simply a TF composition with no muscles present.The posterior wall of the inguinal canal in most specimens consists of a tendinous-like posterior wall formed by the fusion of AIOMA and TAA, and muscle tissue is present in the posterior wall of the inguinal canal in some humans.

We found that the inguinal canal is a musculotendinous canal.The tenosynovial tissue of the PWIC includes TAM and AIOMA, and there are two types of tenosynovial tissue in the posterior wall; The one is the two layers of tenosynovial membrane run parallel to each other, and at this time, there are two layers of tenosynovial tissue in the posterior wall, which is at a low risk of hernia, and is the majority of specimens of the PWIC that we see in the clinical autopsy as well as in the The other type is TAM and AIOMA are staggered, at this time, the PWIC is only a layer of tenosynovial tissue, because of hernia susceptibility factors, at this time, the area where the two layers of tenosynovial membrane of the PWIC intersect becomes a weak area, and is prone to inguinal hernia, and at this time, there are two kinds of hernias in this area, one is if the tenosynovial membrane of the PWIC in this area is not completely broken, and only becomes a weak area, there is no risk for hernia. There are two types of hernias that occur in this area, one is if the area of the PWIC tendon membrane is not completely ruptured and only becomes a weak area, at this time the PWIC with the inguinal hernia occurs only as a bulging mass; the other type is that the tendon membrane of the PWIC is ruptured, and the inguinal hernia mass with the defect of the PWIC can enter into the inguinal canal and enter into the scrotum, this type of hernia mass can enter into the scrotum, and we have met this kind of hernia mass into the scrotum cases in clinic.

Through anatomical observation, that the tissue origin of PWIC is muscle, tendon membrane or coexistence of muscle and tendon membrane, and TF is the intra-abdominal fascia, which is located in the medial side of the blood vessels under the abdominal wall, and does not participate in composing the PWIC. the inguinal canal is a musculotendinous canal, there is no presence of fascial tissue, and the TF is not involved in the composition of the PWIC.

We found that the spermatic cord located in the inguinal canal was not free, but was closely connected to the inguinal canal, and a dense layer of fibrous connective tissue was seen to connect the spermatic cord to the inguinal canal during clinical surgery. The surface of the spermatic cord is encircled by the cremaster, which fuses dorsally with the spermatic cord to form the levator ani tendon membrane, which is derived from the IOMA, TAM, and its tendon membrane. Based on the anatomical position of the spermatic cord within the inguinal canal, we hypothesized that the spermatic cord is anchored to the inguinal ligament by the tendinous membrane of the cremaster, together with the tendinous fibers of the PWIC.Robert Bendavid histologically found that the apical portion of the intra-abdominal oblique tendinous membrane had some muscle fibers from the cremaster [19]; Arslani N also proposed in recent years

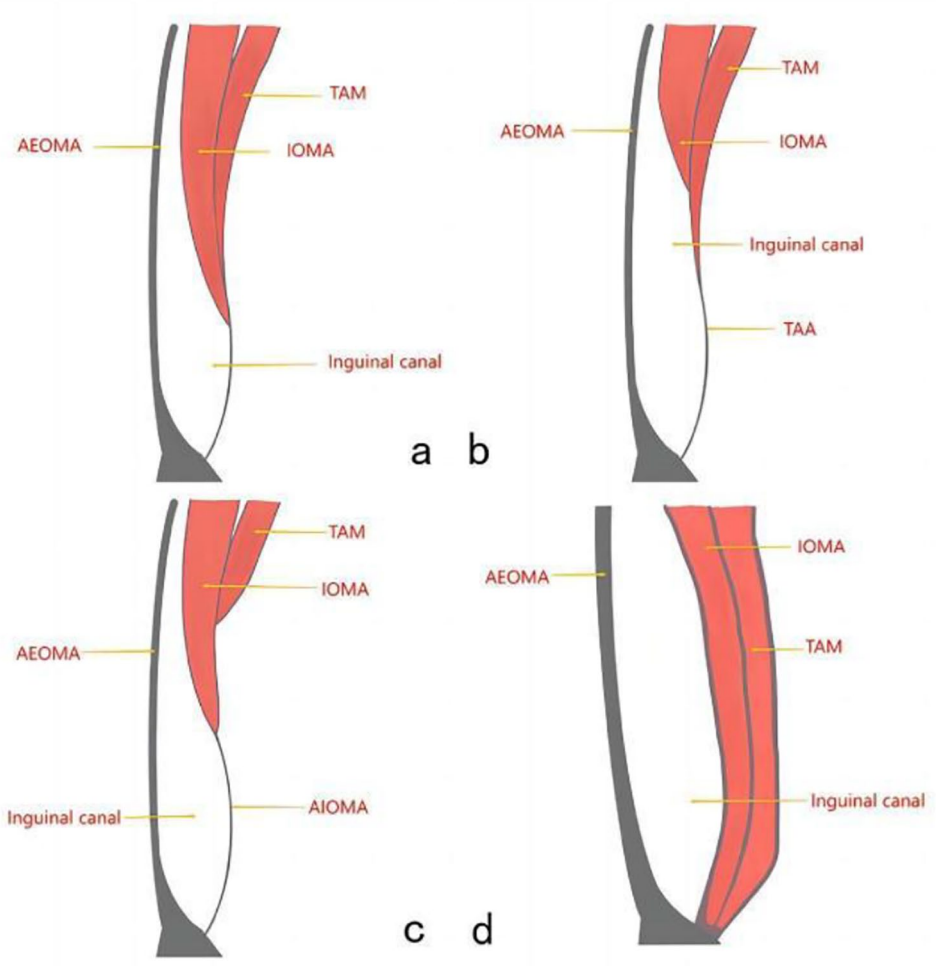

Fig. 6 **a**: The type of PWIC is aponeurosis formed by the fusion of TAM and AIOMA. **b**: The type of PWIC is TAM and TAA. **c**: The type of PWIC is IOMA and AIOMA. **d**: The type of PWIC is IOMA and TAM

In autopsy, we found that in the inguinal region according to the anatomical level layer by layer free abdominal wall flat muscle and its tendon membrane (abdominal wall three flat muscle tendon attachment points: EOMA, IOMA, TAM), we can find in the abdominal wall, three types of flat muscle surface and dorsal surface are found in the thin fascial tissue, continued to the stopping point of the muscle in the anterior abdominal wall (the stopping point of the internal oblique and abdominal muscle in the bilateral inguinal area of some cadavers can be extended to the pubic symphysis), the fusion of a single layer of tenosynovial-like structure is relatively tough and dense, which is the fusion of AIOMA and TAA, at this time, the AIOMA and TAA form a dense fusion to form the posterior wall of the inguinal canal together, we can find a thin layer of fascial organization along the umbilicus. At this time, we can see Inferior abdominal artery running along the medial umbilical fold, and along the Inferior abdominal artery, a layer of thin transverse fascia with a yellow fat layer was bluntly detached, and we regarded this layer of fat above the transverse fascia as extraperitoneal fat, TF was a layer of membranous tissue located in the deeper layer of the TAM and the tendon membrane (behind the posterior sheath of the rectus abdominis), and there were Inferior abdominal artery and Corona Mortis passing through it between the TF and the TAM. (Fig. 7a)

In male cadaveric specimens, the spermatic cord was pierced out from the internal ring, and the sparse connective tissue between the AIOMA and the spermatic cord was easy to separate, no blood vessels and nerves were seen, (Fig. 7b.c), the spermatic cord was anchored by tough fibrous connective tissues located underneath it to the inguinal ligament, and by pulling up the spermatic cord, it could be seen that some muscle fibers of the cremaster on the surface of the spermatic cord were continued to the lateral side of the inguinal canal. And continued and fused with muscle fibers from IOMA and TAM, the relationship between the tissues is close, can not be separated; (Fig. 7d) Under the spermatic cord can be observed below the tough connective tissue connecting spermatic cord will be divided into two spaces, The spermatic cord is not "free" in the inguinal canal until the tough fibrous connective tissue beneath the spermatic cord is sharply separated

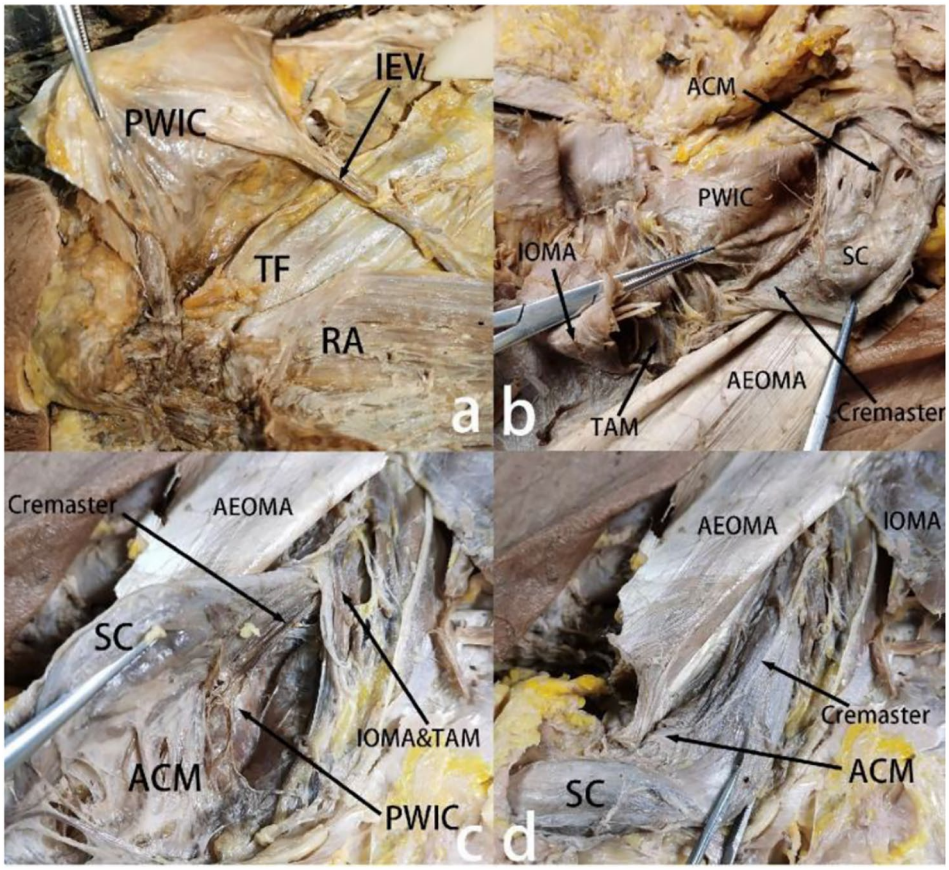

Fig. 7 **a**: TF of the anterior approach. **b**: the spermatic cord of the male specimen is fixed in the inguinal canal by the epididymis aponeurosis. **c**: in another male specimen, the muscle fibers of the epididymis muscle fused to form the epididymal aponeurosis, and the spermatic cord was The spermatic cord was fixed to the inguinal canal. **d**: the muscle fibers of theIOMA, TAM extend to the epididymis muscle

We found in two male cadaveric specimens, the anterior wall of the inguinal canal consisted of AEOMA and AIOMA, and the cremaster on the surface of the spermatic cord had nothing to do with the EOMA and its tendinous membrane, the source of its tissues was the IOMA and the TAM, the spermatic cord penetrated through the external ring and then directly into the scrotum, and the tough fibrous connective tissue that anchors the spermatic cord extends from the spermatic cord just below it into the inguinal ligaments

that the spermatic cord of the inguinal canal is surrounded by fibers of the levator muscle [20]. It also confirms our speculation.Based on our anatomical findings, sharp separation is required when surgically freeing the spermatic cord, and that separating the spermatic cord at the inferior margin of the arcuate margin of the inguinal canal is the safest, easy to recognize and separate, and avoids damage to the spermatic cord.

Conclusion

In summary, PWIC is mainly composed of Internal oblique muscle of abdomen (IOMA), Aponeurosis of internal oblique muscle of abdomen(AIOMA), Transverse abdominal muscle (TAM), and Transverse abdominal aponeurosis(TAA) as the following four types: (1) TAM and AIOMA fused to form a tendinous layer; (2) IOMA and TAM form the posterior wall of the muscle in the PWIC; (3) IOMA and AIOMA continue in the PWIC; 4)TAM and TAA continue in the PWIC. The different structures of PWIC are closely related to the occurrence of inguinal hernia. TF is a thin fascial tissue with only one membrane structure, and TF is not involved in the composition of PWIC, so this fascia is not associated with the occurrence of resistant inguinal hernia. The spermatic cord wandering in the inguinal canal is fixed to the lower wall of the inguinal canal by the inner inguinal tube, which is a tendinous tube. These new findings help us to achieve more precise separation and more rapid injury in inguinal hernia surgery.

Abbreviations

TF	Transverse fascia
TAM	Transverse abdominal muscle
EOMA	External oblique muscle of abdomen
IOMA	Internal oblique muscle of abdomen
AEOMA	Aponeurosis of external oblique muscle of abdomen
RA	Rectus Abdominis
AIOMA	Aponeurosis of internal oblique muscle of abdomen
TAA	Transverse abdominal aponeurosis
PWIC	Posterior wall of inguinal canal
SC	Spermatic Cord

IEV	Inferior Epigastric Vessel
ACM	Aponeurosis of Cremaster Muscle
RLU	Round Ligament of Uterus
C	Cremaster

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Author contributions
Yang Xiao and Cong Tong conceived the study and drafted the manuscript, Yang Xiao and Zheqi Zhou discussed and wrote a manuscript on Anatomical observations on 30 cadavers: new insights into the relationship between the posterior wall of the inguinal canal and the cremaster. Yan Likun participated in discussions about the manuscript, while Cong Tong guided and studied the study and revised the manuscript. All of the authors reviewed the manuscript.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethical approval and consent to participate
This study was approved by the ethics committee (Biomedical Ethics Committee of Xi'an Jiaotong University, approval number: 2014 – 0303). The research reported in this paper was performed in compliance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Writen informed consent was obtained from the immediate family members of the deceased for educational and scientifc research purposes. The format of the informed consent form is in line with the guidelines of the China Organ Donation Administrative Center.

Consent for publication
Not applicable.

Conflict of interest
The authors have no conflicts of interest to declare.

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References

1. Van veenendaal N, Simons M, Hope W, et al. Correction to: Consensus on International guidelines for Management of Groin hernias.[J]. Surg Endosc. 2020;34(6):2378.
2. Dreuning Kelly Ma,Barendsen Rinse W,Van Trotsenburg as Paul,Twisk Jos Wr,Sleeboom Christien,Van Heurn Lw Ernest,Derikx Joep Pm. Inguinal hernia in girls a retrospective analysis of over 1000 patients.[J]. Journal of pediat.
3. Cordero-bermúdez Martínez-hoedJ, García-pastor K. The Inguinal Hernia Management in Costa Rica according to a Survey between surgeons. Result comparison with 2018 International Groin Hernia guidelines.[J]. BMC Surg. 2021;21(1):152.
4. Lichtenstein IL, Shulman AG, Amid P K,Montllor MM. The tension-free hernioplasty[J]. Am J Surg. 1989:1572.
5. Fruchaud H. Anatomie Chirurgicale des Hernies de L'Aine. Paris G. Doin, 1956. [J].
6. Zhang J. Inguinal anatomy: a new perspective from fascia anatomy[J]. Chinese J Hernia Abdom Wall Surg (Electronic Edition). 2017;11(5):324–8. https://doi.org/10.3877/cma.j.issn.1674-392X.2017.05.002.
7. Jian-Ping CH-PW, Zhao J. -Zong. Surgery. 9th edition [M]. People's Health Publishing House; 2018. p. 313J.
8. Skandalakis JE, Colborn GL, Androulakis JA, Skandalakis LJ, Pemberton LB. Embryologic and anatomic basis of inguinal herniorraphy[J]. Surg Clin North Am. 1993;73(4):799–836.
9. Pierpont R, Grigoleit A,Finegan M. The Transversalis Fascia: a practical analysis of an Enigma.[J]. Am Surg. 1969;35(10):737–40.
10. Colborn GL, Skandalakis JE. Laparoscopic cadaveric anatomy of the inguinal area[J]. Probl Gen Surg. 1995;12(1):13–20.
11. Condon R. Reassessment of groin anatomy during the evolution of Preperitoneal Hernia Repair.[J]. Am J Surg. 1996;172(1):5–8.
12. Ohsawa J, Tanaka M, Oka H, et al. A New Method of Hernioplasty for adult groin hernias centering on repair of the Transversalis Fascia.[J]. Japanese J Surg. 1991;21(4):381–91.
13. Wolloscheck T, Gaumann A, Terzic A, et al. Inguinal hernia: measurement of the Biomechanics of the Lower Abdominal Wall and the Inguinal Canal.[J]. Hernia: J Hernias Abdom Wall Surg. 2004;8(3):41–233.
14. Cooper AP. The anatomy and surgical treatment of abdominal hernia. London[J]: longman and Co; 1804.
15. Standring S. Gray's Anatomy: 39th edition[M]. Peking University Medical Press; 2008.
16. Bendavid R, Howarth D. Transversalis fascia rediscovered[J]. Surg Clin North Am. 2000:80(1).
17. Anson B, Morgan E, Mcvay C. Surgical anatomy of the Inguinal Region based upon a study of 500 Body-halves[J]. Surg Gynecol Obstetr. 1960;111:707–25.
18. McVay CB, Anson BJ. Fascial continuties in the abdominal, perineal, and femoral regions.[J]. Anat Rec. 1938;71(4):401–7.
19. Bendavid R. The unified theory of hernia formation.[J]. Hernia: J Hernias Abdom Wall Surg. 2004;8(3):6–171.
20. Arslani N, Gajzer B, Papeš D, et al. A New Approach for Transversalis Fascia reinforcement in Lichtenstein's inguinal hernia repair.[J]. Surg Today. 2013;43(2):211–4.

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