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Macroscopic demonstration of the male urogenital system with evidence of a direct inguinal hernia utilizing room temperature plastination

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Abstract

The male urogenital system represents a morphologically complex region that arises from a common embryological origin. However, it is typically studied separately as the excretory system is dissected with the posterior wall of the abdomen while the reproductive features are exposed with the pelvis and perineum dissection. Additionally, the reproductive structures are typically dissected following pelvic and perineal hemisection obviating a comprehensive and holistic examination. Here, we performed a dissection of the complete male urogenital system utilizing a 70-year-old donor and room temperature silicon plastination. Identification of a direct inguinal hernia during the dissection facilitated a unique opportunity to incorporate a common abdominal wall defect into the plastination requiring a novel approach to retain patency of relevant structures. Results showed that the typical structures identified in medical gross anatomy were retained in addition to the hernia. Thus, the described approach and the resulting specimen provide valuable and versatile teaching tools for male urogenital anatomy.

Keywords: direct inguinal hernia; genital; male; reproductive; urogenital

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Introduction

In the adult male, the unity between the renal and genital systems and their supporting structures is somewhat subtle. However, the integration of these two systems is quite clear during the embryonic and fetal periods. There is a close developmental association between embryonic kidneys and primitive gonads. Both originate from the intermediate mesoderm in the pelvic region. However, after forming, the embryonic kidneys and testes migrate in opposite directions as their development continues.[1,2] Between gestational week (gw), 6 and 9 the kidneys ascend into the abdominal cavity.[1,3] By gw 6, in the male fetus, the primitive gonads are directed towards the testis fate by the Y chromosome, and specifically Y-encoded SRY.[2,4] The testes descend abdominally between gw 8 to 12.[2] Once the testes enter the inguinal canal around gw 24, they contribute to the formation of the canal as they migrate inferomedially to enter the scrotum by gw 35.[5]

The common developmental origin of the kidneys and testes leads to common excretory sites for both systems while their divergent migration patterns result in long testicular vasculature extending from upper-mid abdomen to scrotum.[1,2] In the adult male, the urethra is the common exit site for products of the kidneys and testes with their accessory glands. There is also a hormonal relationship between these two regions. From an endocrine perspective, the primary source of male testosterone are the Leydig cells of the testis.[6] However, the adrenal glands that are positioned superior to the kidneys also serve as a source of androgens in the adult.[7,8]

The common developmental origin of the testes and kidneys results in a persistent link in the adult. Because of this inherent association it seems logical to showcase these two systems in a single urogenital dissection. The involvement of the endocrine system and influence of migration on the vascular systems of these organs during develop-

ment also makes a clear case for maintaining pertinent vasculature with a urogenital dissection. However, general instructional dissection is usually performed regionally such that the kidneys and adrenal glands, and the pelvis and perineum are investigated separately.[9] This type of division precludes observing the connectivity of structures in these two regions. For example, the typical procedure for viewing the erectile bodies of the penis is achieved through cross-sectional excision of the body.[9] This approach obscures the longitudinal spatial relationships between the corpus spongiosum and the corpora cavernosa, particularly at the dorsal base of the glans. Likewise, the testes and accessory glands are often dissected as individual components so that the concept of their inherent connectedness is lost to the dissector and viewers.

The other common method for viewing the male genital system follows transverse sectioning at approximately L5 (lumbar vertebra 5) with subsequent hemisectioning of the pelvis. While a hemisection allows the observer an excellent *in situ* view of the main focal points of the male genitalia, the kidneys are often missing from this approach, as well as the vasculature of the testis. At the same time the inclusion of the bones and ligaments of the pelvis obscures spatial relationships between the bladder, prostate, urethra, erectile bodies, and muscles at the bulb and crura of the penis.

A dissection that retains the entire urogenital system and its associated vasculature as one entire unit would allow for a readily apparent comprehensive understanding of the interlinking between the renal and male reproductive systems along with the impact their embryological development has on the accompanying vasculature in the adult.

Here, our first goal was to perform a dissection that maintained connections between urogenital components so that critical spatial relationships between distant regions would be readily apparent. Our second goal was to eliminate non-urogenital structures to facilitate a 360-degree view of the entire system while avoiding organ transection in an effort to maintain normal morphology. Our third goal was to increase the instructional collection of anatomical plastinations for educational purposes among medical and allied medical students at our institution. During the dissection, a left direct inguinal hernia was discovered providing a unique opportunity to successfully preserve a hernia and its patency in the human male. To our knowledge, this study is the first description of plastination of a direct inguinal hernia except what seems to be an anecdotal observation of a hernia at a plastination demonstration.[10,11] Thus, our fourth and final goal was to devise a method to preserve the direct hernia so that it could be demonstrated within the final plastinated specimen.

Materials and Methods

All procedures were performed in accordance with protocols approved by the biosafety committee at John A. Burns School of Medicine, University of Hawai'i at Mānoa. Human anatomical material was utilized following standard operating procedures.[12]

Embalming

The body was washed thoroughly using antibacterial soap, with special care paid to the eyes, nose and mouth. The body was elevated above the table surface using body blocks at critical points (neck, shoulders, lumbar region and heels) to avoid constricting arteries in the back and buttocks. Anatomical embalming was a three-day process. Day 1: Embalming cannulas were placed in the carotid arteries directed superiorly into the head and inferiorly into the body. Injection was done at a moderate/high pressure and a slow flow rate (~6-8 oz. per min). The embalming solution consisted of: 1 L formaldehyde, 1 L of methanol, 2.5 L of isopropyl Alcohol, 0.5 L of glycerin and enough water to make 12 L of total embalming solution. There was no blood drainage during the embalming process. Once the head was perfused, cannulas were switched and the body injected with the remainder of the embalming solution. Day 2: 12 L of embalming solution was injected. Day 3: Another 12 L of embalming solution was injected. When the body was adequately perfused, the gluteal region was hypodermically injected to increase overall vascular pressure. The cadaver was placed into a heavy-duty body bag and stored.

Dissection

The dissection protocol was derived from several sources including: Clark's Anatomy and Physiology, Moore's Clinically Oriented Anatomy, Gilroy's Atlas of Anatomy, Tank's Dissector, and The Physiology of Reproduction.[9,13–17]

Cutaneous tissue removal

Skin was removed from the abdominal, anterior and lateral pelvic, and thigh regions but the skin and fascia of the penis, scrotum and perineum were retained.

Excising the abdomen

An excision was made along the midline of the abdomen that ran from xiphoid process to pubic symphysis. The superior cut was extended laterally following the path of the costal margin. The inferior cut was extended laterally parallel but superior to the inguinal canal medially and superior to the inguinal ligament laterally.

Preparing the abdomen

Once the abdomen was opened, the alimentary canal and associated organs were removed from the abdominal cavity. The abdominal aorta and inferior vena cava were isolated. Both right and left kidney and adrenal glands were identified and the left and right renal arteries and veins were traced back to the abdominal aorta and inferior vena cava, respectively.

Kidneys and vessel release

The kidneys, renal vessels and ureters were manually released from the renal capsule and surrounding fascia while the adrenal attachment to the kidney was preserved. The right and left testicular veins were identified and retained at their origins. A pair of inferior incisions were performed along the internal and external iliac arteries and veins approximately 6 cm distal to their bifurcation at the common iliac artery and vein, respectively. Remaining vessels were removed.

Detachment of the rectum and anus

The legs were maximally abducted and a superficial incision was made that encircled the posterior scrotum. Externally the skin of the perineum was carefully reflected, up to the perimeter of the anus. Internally the connective tissue surrounding the anus and rectum was excised and both structures were removed from the perineum.

Degloving the penis

The skin around the root of the penis was reflected, except for skin of the scrotum. The penis was degloved by cutting the fascia (Buck's fascia) separating the skin from the erectile bodies; attachment to the scrotum was retained to facilitate removal of scrotal skin subsequently. Complete degloving was achieved by releasing the foreskin.

Removing the scrotum and freeing the testes

The skin of the scrotum was removed from the testes by excising the underlying dartos fascia. Care was taken to preserve the testes and spermatic cord structures including the pampiniform plexus, epididymides and ductus deferentes. Palpation was then used to locate the spermatic cord inside the inguinal canal. Palpation along the path of the spermatic cord was also used to bluntly check for the presence of any hernias. Once each testis was released, the spermatic cord was followed superiorly and loosened manually.

Removal of the urogenital system and vasculature from the body

The testes and spermatic cord were reflected superiorly into the abdominal cavity. Bone cutters were used to excise the left and right superior pubic and ischiopubic rami. The entire urogenital system and vasculature were then removed from the abdominal and pelvic cavities.

Bone removal and perineal muscle dissection

The bulbospongiosus and ischiocavernosus muscles were separated from the isciopubic ramus as completely as possible, while simultaneously maintaining their connection to the bulb and crura of the penis respectively. The remaining portion of the deep transverse perineal muscle between the base of the penis and prostate was retained in an effort to protect the bulbo-urethral (Cowper's) glands and the intermediate part of (membranous) urethra within. The lateral puboprostatic ligament was identified and preserved. All excess tissue and muscle fragments were removed from the region so that relevant structures including the bulb and crura of the penis with bulbospongiusus, ischiocavernosus, deep transverse perineal, and external urethral spincter muscles, prostate, urinary bladder, ureters, seminal vesicles and ductus deferentes were all clearly visible.

Dissection of the body of the penis

The remaining fascia was removed from the body of the penis. Care was taken to preserve the deep dorsal dorsal vessels of the penis. The fascia between the glans of the penis and corpora cavernosa was teased away facilitating separation of the corpora cavernosa from corpus spongiosum and glans.

Demonstration of accessory glands

Adipose and minor tissue remnants were removed from the surface of the bladder, seminal vesicles, and prostate. At the apex of the prostate, the deep transverse perineal muscle was delicately dissected revealing the bulbo-urethral glands and membranous urethra.

Inguinal hernia

During the dissection a direct inguinal hernia on the left side was discovered at the inferomedial margin of the medial inguinal fossa (Hesselbach's triangle). The protocol was modified slightly to preserve this pathology. The left spermatic cord and inguinal canal were preserved and remained attached to the lateral side of the herniated abdominal peritoneum. The medial side of the hernia was kept in contact with the left lateral portion of the bladder.

Plastination

Following dissection, the urogenital specimen was rinsed overnight in running tap water. A Foley catheter (18 Fr. 5cc) was introduced distally into spongy urethra. The specimen was placed in a chemically resistant bucket with a sealable lid (Gamma lids). Dehydration was performed in an explosion-proof freezer (-25°C, Lab-Line Frigid Cab)

in ≥97.5% acetone bath. The percentage of acetone was checked weekly and adjusted to 97.5% after the 1st and the 2nd week and to 99.5% after the 3rd week. After greater than 99% of acetone was achieved, the specimen was considered dehydrated and transferred to room temperature. Degreasing occurred during submersion in acetone (>99% and fresh 100%, 4 weeks each) at room temperature. For impregnation, the specimen was removed from the acetone and submerged into a bath of PR10 silicone solution, NCS10 polymer/NCSVI cross-linker (Silicones, Inc.) diluted 100:8 in water, and placed in a medium sized vacuum chamber attached to an oil-free two-stage vacuum pump (Labport, KNF, Neuberger) at room temperature. Forced impregnation (2 cm Hg) was achieved after 48 hr.

Following impregnation, the specimen was removed from the vacuum chamber, placed on a wire rack, blotted with a paper towel, and allowed to drain for two days. The specimen was lightly coated with NCSIII (catalyst), wrapped in plastic foil and monitored daily. Curing was successfully achieved 30 days after impregnation.

Results
General appearance

The new dissection protocol and the established plastination process used at our institute (*see* Materials and Methods, and for more details) yielded a good quality specimen demonstrating the male urogenital system and associated vasculature (**Figures 1** and **2**).[18] The plastina-
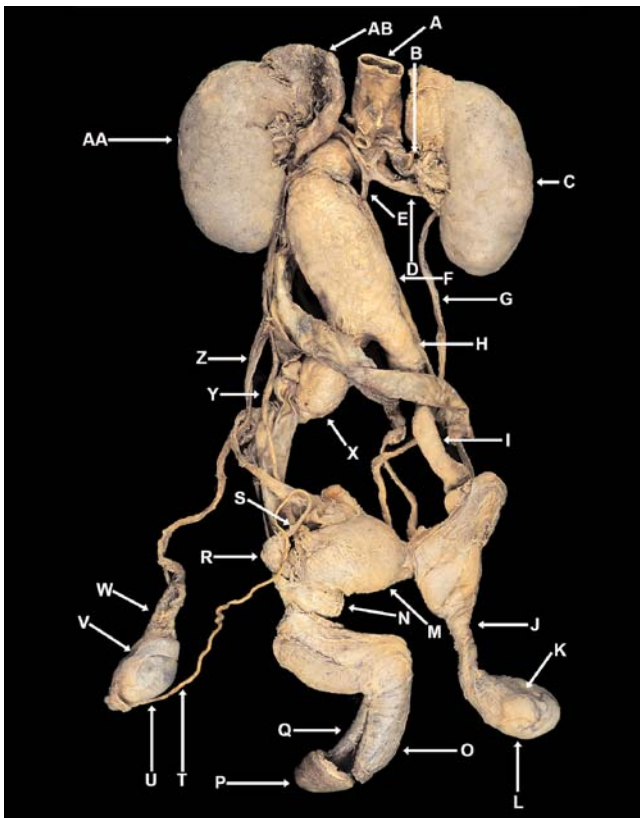

Figure 1. Anterior view of the urogenital system plastination. The structures shown represent a subset of structures required to be identified by medical students performing dissections in Gross Anatomy Laboratory listed in **Table 1**. **A:** abdominal aorta; **B:** left renal artery; **C:** left kidney; **D:** left renal vein; **E:** left testicular vein; **F:** abdominal aorta aneurysm; **G:** left ureter; **H:** left common iliac artery; **I:** left external iliac artery; **J:** spermatic cord; **K:** anterior scrotal artery/vein; **L:** spermatic fascia/parietal layer tunica vaginalis; **M:** bladder; **N:** prostate; **O:** corpus cavernosum; **P:** glans penis; **Q:** corpus spongiosum and spongy urethra patent within; **R:** seminal vesicle; **S:** ampulla of ductus deferens; **T:** ductus deferens; **U:** testis/visceral layer tunica vaginalis/tunica albuginea; **V:** epididymis; **W:** pampiniform plexus; **X:** right common iliac artery aneurysm; **Y:** right ureter; **Z:** right testicular artery/vein; **AA:** right kidney; **AB:** right adrenal gland. [Color figure can be viewed in the online issue, which is available at www.anatomy.org.tr]
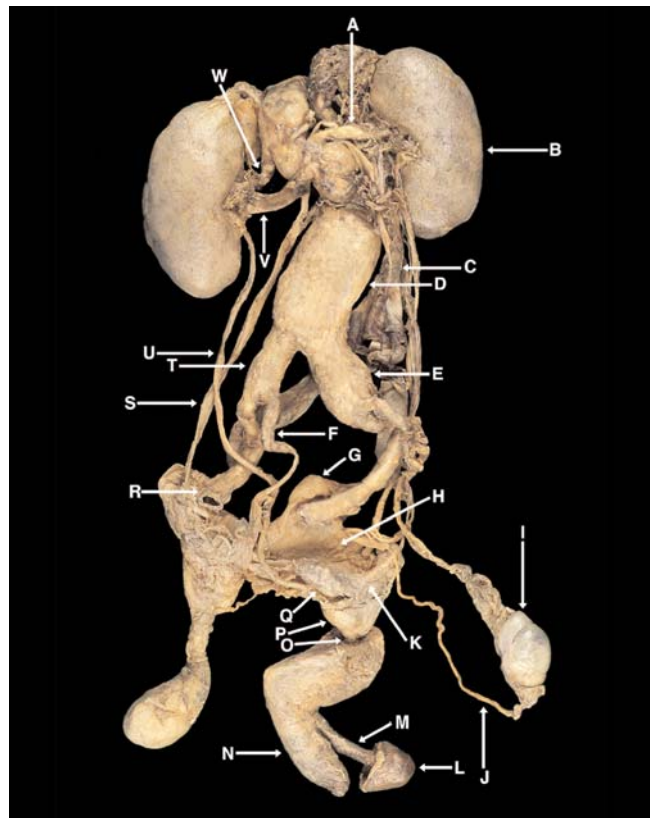

Figure 2. Posterior view of the urogenital system plastination. The structures shown represent a subset of structures required to be identified by medical students performing dissections in Gross Anatomy Laboratory listed in **Table 1**. **A:** right renal artery; **B:** right kidney; **C:** inferior vena cava; **D:** abdominal aorta aneurysm; **E:** right common iliac artery aneurysm; **F:** left internal iliac artery; **G:** median umbilical ligament of bladder; **H:** fundus of bladder; **I:** epididymis; **J:** ductus deferens; **K:** ejaculatory duct; **L:** glans penis; **M:** corpus spongiosum with spongy urethra patent within; **N:** corpus cavernosum; **O:** membranous urethra; **P:** prostate; **Q:** seminal vesicle; **R:** left external iliac artery; **S:** left testicular artery/vein; **T:** left common iliac artery; **U:** left ureter; **V:** left renal vein; **W:** left renal artery. [Color figure can be viewed in the online issue, which is available at www.anatomy.org.tr]

tion was durable, and smaller vessels maintained their general shape (**Figure 3a–d**). The placement of a catheter in the urethra before plastination successfully kept the spongy urethra patent within the corpus spongiosum, which maintained shape (**Figure 3c**). The relationship of the erectile bodies and the muscles at their proximal end

was demonstrated while maintaining the overall structure of the penis (**Figure 3c**).

Male genital organs and glands

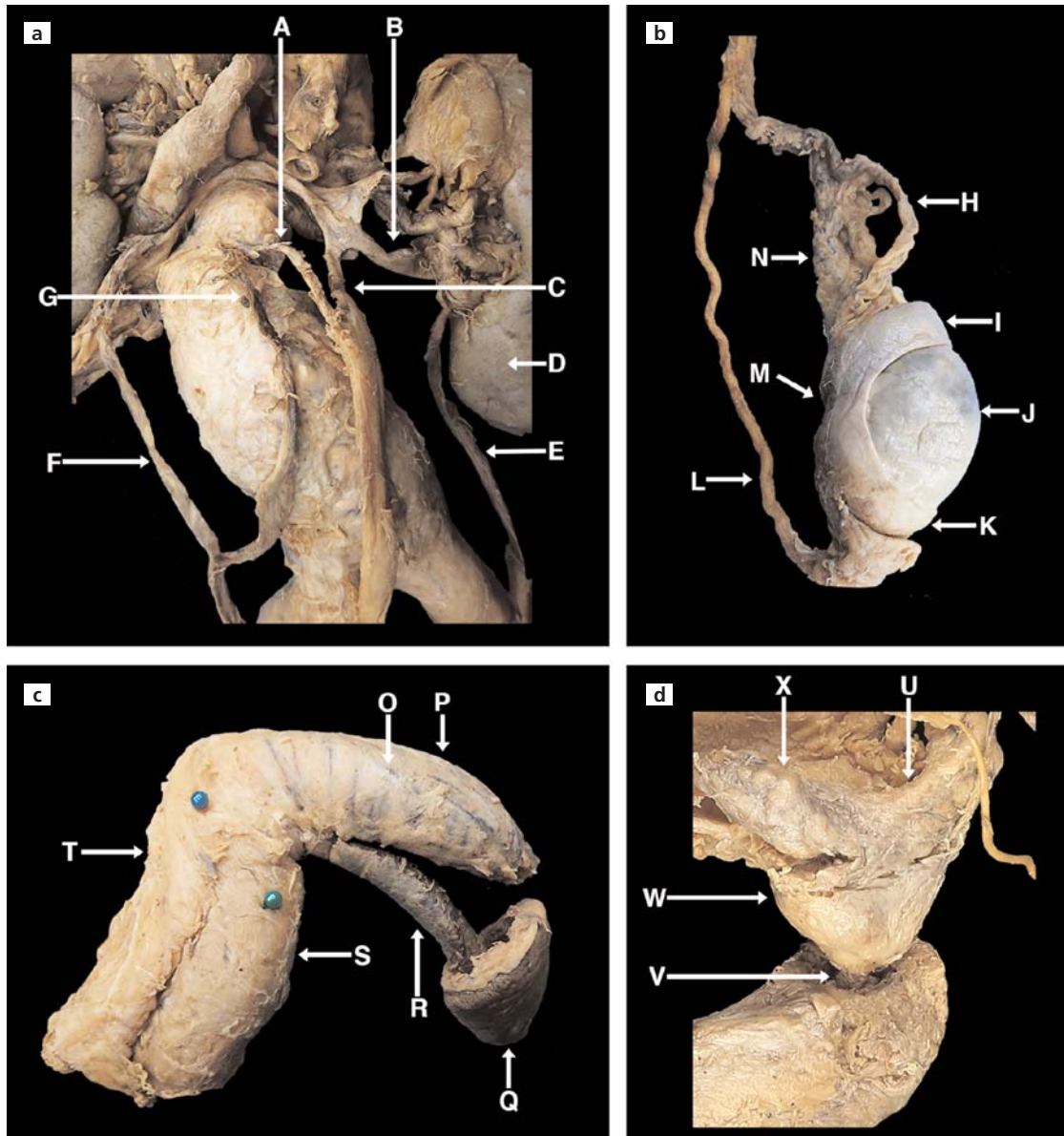The vasculature of the testis at its superior pole retained shape. All three segments of the epididymis were clearly

Figure 3. Higher magnification of selected structures. (**a**) The superior portions of testicular vasculature as they relate to renal structures. (**b**) A lateral view of the right testis showing the scrotal contents viewable when the spermatic fascia is removed. (**c**) The penis: the erectile muscles, erectile bodies and deep venous structures superficial to the corpora cavernosa. Specifically highlighting the association of the corpus spongiosum and the glans penis as the spongy urethra traverses the center of both structures. (**d**) Male reproductive glands and associated structures. **A:** left testicular artery; **B:** left renal vein; **C:** left testicular vein; **D:** left kidney; **E:** left ureter; **F:** right testicular vein; **G:** right testicular artery; **H:** testicular artery; **I:** caput epididymis; **J:** testis; **K:** caudate epididymis; **L:** ductus deferens; **M:** corpus epididymis; **N:** pampiniform plexus; **O:** deep dorsal vein of the penis; **P:** corpus cavernosum; **Q:** glans penis; **R:** corpus spongiosum; **S:** bulbospongiosus muscle *(green pin head)*; **T:** ischiocavernosus muscle *(blue pin head)*; **U:** right ejaculatory duct; **V:** membranous urethra; **W:** prostate; **X:** left seminal vesicle. [Color figure can be viewed in the online issue, which is available at www.anatomy.org.tr]
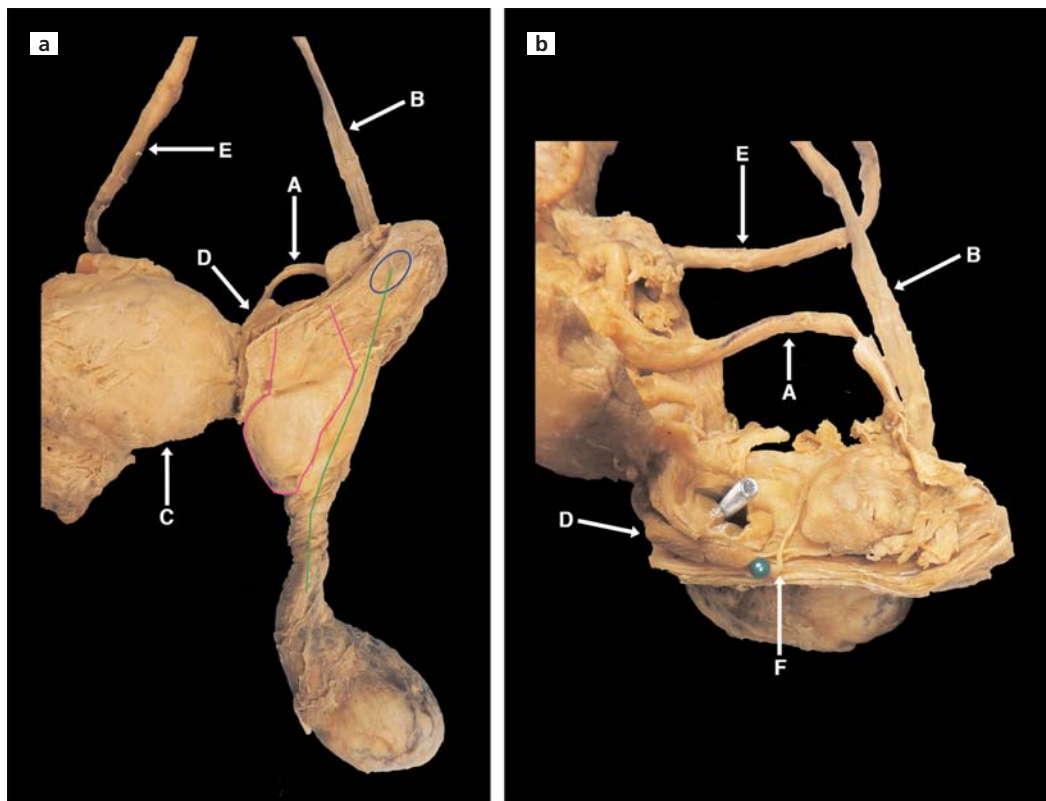
Figure 4. Demonstration of direct inguinal hernia and validity of the technique used to preserve pathology. (**a**) Left anterior view demonstrating path of abdominal peritoneum herniation (**pink**) in relation to spermatic cord (**green**) and deep inguinal ring (**blue**). (**b**) Left superior view demonstrating location of abdominal peritoneum herniation (*needle*) in relation to inferior epigastric artery and rectus abdominus muscle (*green pin head*). **A:** ductus deferens; **B:** testicular artery and vein; **C:** bladder; **D:** rectus abdominus muscle (*green pin head*); **E:** ureter; **F:** inferior epigastric artery. [Color figure can be viewed in the online issue, which is available at www.anatomy.org.tr]

visible as they follow the curvature of the posterior testis and direct sperm to the ductus deferens. The seminal vesicles and prostate along with the ejaculatory duct between them were maintained (**Figure 3b**). Most likely due to its small size and delicacy, the bulbo-urethral gland was inadvertently removed with the external urethral sphincter muscle during dissection to reveal the membranous urethra (**Figure 3d**).

Pathologies

The direct inguinal hernia remained patent after plastination (**Figure 4**). The abdominal peritoneum formed a thickened outer sheath and protruded laterally and inferiorly; however, it remained distinct from the inguinal canal and its contents (**Figure 4a**). The herniated peritoneal pouch retained a position lateral to the urinary bladder and medial to the deep inguinal ring and protruded into the medial inguinal canal adjacent to the spermatic cord as the spermatic cord approached the superficial inguinal ring (**Figure 4a**). The hernia also projected anteriorly towards the anterior abdominal wall, but remained posterolateral to the rectus abdominus muscle (**Figure 4b**). Thus, it protruded slightly medial to the medial inguinal fossa (Hesselbach's triangle). Distortion and closure of the hernia during plastination was prevented possibly due to the abnormal thickening of the peritoneum as well as the retention of its connections extraperitoneally (**Figure 4b**). The retention of the spermatic fascia also preserved the anterior scrotal artery and vein (**Figure 1**).

After dissection it was obvious that a large abdominal tumor had caused extensive deformation of the abdominal aorta. The tumor and associated fibrous tissue covered the length of the abdominal aorta and common iliac arteries while further binding these vasculature structures to a fibrous mass that encased parts of the stomach, pancreas and large intestine. The same region also seemed to have suffered an abdominal aortic aneurysm (**Figures 1** and **2**). Despite these obstacles, the vasculature was maintained, though it appeared somewhat morphologically abnormal. The origins of the right and left testicular arteries and ter-

mination of the right and left testicular veins were intact and visible (**Figure 3a**).

Efficacy as a teaching tool

The plastination was assessed for instructional relevancy by determining the number of structures that could be identified compared to a standard list of structures required for observation by medical students during gross anatomy dissection of the abdomen and pelvis and perineum (**Table 1**). Typically, many prosections and plastinations are necessary to cover all of the structures on the list. However, over 50% of the structures on the list were identified on the single plastinated specimen generated in this study. Over one-third of the structures absent from

the specimen were either nerves that were not on the dissection or structures that would require transecting part of the dissection to be visible. The latter was specifically not performed to maintain the general morphology of the structures that were highlighted in the dissection.

Discussion

Here, we detailed an alternative way of dissecting the renal and male genital systems. Dissection was followed by a plastination method that can be used to preserve the specimen for years of instructional use. We produced a complete urogenital dissection that has been removed from the abdomen and pelvis in such a way that connections between components are readily apparent in a 360°

Table 1
Efficacy of specimen as teaching tool.

Male Urogenital Relevant Structures from MS1 Identify List*	
Structure Present (Figure #)	**Structure Not Present**
Adrenal gland (1)	Artery of the bulb (penis/vestibule)
Ampulla of ductus deferens (1)	Artery to ductus deferens
Bulbospongiosus m (3 bottom left)	Bulbo-urethral glands
Corpus cavernosum (3 bottom left)	Deep artery of the penis
Corpus spongiosum (3 bottom left)	Deep transverse perineal m
Deep dorsal vein of the penis (3 Bottom left)	Dorsal artery of the penis
Ductus deferens (1, 2, 3 top right, 4)	Dorsal nerve of penis/clitoris
Ejaculatory ducts (3 bottom right)	Ganglion of sympathetic trunk
Epididymis (1, 3 top right)	Internal pudendal artery
Fundus of bladder (2)	Internal urethral orifice[†]
Glans penis (1, 2, 3 bottom left)	Pelvic splanchnic nerves
Internal iliac artery (2)	Posterior scrotal/labial nerve
Ischiocavernosus m (3 bottom left)	Prostatic urethra[†]
Kidney (1, 2)	Prostatic duct[†]
Median umbilical ligament of bladder (2)	Prostatic plexus of veins
Membranous urethra (3 bottom right)	Prostatic capsule
Pampiniform plexus (1, 3 top right)	Prostatic utricle
Penis (3 bottom left)	Rete testis[†]
Prostate (1, 2, 3 bottom right)	Scrotum
Renal artery (1, 2)	Seminal colliculus
Renal vein (1, 2, 3 top left)	Seminiferous tubules[†]
Seminal vesicle (1, 2, 3 bottom right)	Sphincter urethrae[†]
Spermatic cord (1, 4 left)	Spongy urethra[†]
Testicular artery (1, 3 top, 4)	Trigone of bladder[†]
Testicular vein (1, 3 top, 4)	Tunica dartos
Testis (1, 3 top right)	Ureteric orifice[†]
Tunica albuginea (1)	Urethral artery
Tunica vaginalis (1)	
Ureter (1, 2, 3 top left, 4)	
Urinary bladder (1, 4 left)	
Total 30/57	Total 27/57
52.6%	47.4%

*Structures present on specimen were compared to the male urogenital relevant vocabulary list of structures typically required to be identified by medical students performing dissections in Gross Anatomy Laboratory. [†]Internal structure that requires transection of the prosection for viewing (in general transection was counter to the purpose of this dissection (*see* Results, Efficacy as a teaching tool).

view. This represents a valuable alternative to regional dissections, which treat the component parts as separate entities; or pelvic hemisection, which can at times omit components or mute their spatial relationships.

Thorough dissection of the erectile bodies after removal of the fascia encasing them (Buck's fascia) was a conscious dissection decision. This approach allowed for a much better understanding of the continuity between the corpus spongiosum and glans, while concurrently demonstrating the termination of the corpora cavernosa distally at the proximal end of the dorsal glans. These relationships cannot be studied when the penis is simply excised cross-sectionally midway along the body.

Tissue dehydration occurs as a result of the plastination process thus raising concerns regarding the retention of urethral morphology. Catheterization was performed in an attempt to overcome this problem. However, success was limited since the proximal portion could not be reached and the urethra lacked patency at its origin. Future efforts will utilize smaller tubing or perhaps something solid such as a rounded flexible plastic rod so that the entire length of the urethra can be catheterized with ease.

The demonstration of bladder morphology did not achieve expectations since the bladder became compacted unexpectedly during plastination. Despite this compaction, structures such as the fundus and median umbilical ligament of the bladder were visible. Future attempts may utilize packing or inflating the bladder, via a small incision, to maintain its shape.

Preservation of the testicular vasculature all the way to arterial origin at the abdominal aorta, and venous termination at either the inferior vena cava or the left renal vein was another significant component of the dissection. The decision to not transect the spermatic cord or its contents allowed similarities and differences between testicular vasculature to be observed. Specifically, the strong 90° angle of the left testicular vein at the left renal vein is anatomically divergent from the much more acute angle the right testicular vein forms with the inferior vena cava. This left-right disparity is linked to a higher prevalence of varicocele, a common male reproductive pathology affecting the pampiniform plexus, on the left side.[19]

The fortuitous finding of a direct inguinal hernia necessitated divergence from our original dissection agenda. The presence of the direct inguinal hernia gave us an excellent opportunity to demonstrate a common male pathology from an anatomical viewpoint. When strategizing how best to preserve the pathology, the decision was made to forgo transection of the testis ipsilateral to the direct inguinal hernia. The intention was that by retaining the spermatic fascia and tissue around the inguinal canal,

the identifying features of the direct inguinal hernia would remain readily apparent after plastination.

About 75% of abdominal hernias in adults occur in the inguinal canal. A recent study found there were 770,000 cases in the United States during 2003, accounting for about 5% of Americans with a 9:1 male to female ratio.[20–22] Examining for the presence of a hernia is typically performed as part of a routine physical for males and about 25% of American men are expected to have a medically recognizable inguinal hernia.[23] Due to this prevalence, hernia repair has become the most common routine surgical procedure for general surgeons and is divided between two surgical treatments: mesh-free repair or tension-free mesh repair.[20,24,25]

According to a recent randomized study of men who had asymptomatic or minimally symptomatic inguinal hernias 53% were indirect (i.e. entering the inguinal canal laterally via the spermatic cord and deep inguinal ring) and 41% were direct.[26] Generally, indirect inguinal hernias are more prevalent in young men and boys while direct inguinal hernias are more prevalent in older men.[27,28] Indirect inguinal hernia at a young age is most often due to persistent patency of the of processus vaginalis after development, while direct inguinal hernia in the elderly is thought to be linked to compromised integrity of the abdominal wall at the medial inguinal fossa (Hesselbach's triangle).[27–31] Treatment of either kind of inguinal hernia is the same from a surgical perspective, but classification distinguishing between direct and indirect inguinal hernia, is still a dominant part of diagnosis.[32] There is also a growing recommendation to not perform a preoperative diagnosis of direct versus indirect inguinal hernia, as the preoperative diagnosis often does not match the intraoperative findings.[33,34]

The dissection and plastination technique described above allowed for observation of a clear and classic direct inguinal hernia in the context of surrounding structures and reproductive organs often affected by its presence. Although distinction between direct and indirect inguinal hernia may not be a critical part of preoperative diagnosis, intraoperative distinction is vital for treatment at the correct location. Further, there is still a great deal to be learned about inguinal hernias, especially in light of the continued discourse on proper treatment in regards to hernia recurrence and pain management of this common pathology.[32,35] If we are afforded an opportunity to plastinate another hernia, it could be prudent to pack the hernia with material that can be removed after plastination to ensure patency of the specimen.

Originally one testis was to be transected from pole to pole after plastination to demonstrate the internal structures. The unexpected appearance of a direct inguinal her-

nia, which we opted to feature in our dissection, necessitated retaining the spermatic fascia and connective tissue of the spermatic cord of the ipsilateral testis. Barring the presence of another testis related pathology in future dissections, one testis will be kept intact while the other will be transected from pole to pole such that internal structures will be visible.

We have previously demonstrated the general effectiveness of plastinations as teaching tools.[36] The specimen detailed in this manuscript represents a teaching tool with high impact in terms of medical education at our institution. This single specimen allows for viewing of the collection of anatomical structures, investigation of which would usually require two or more specimens. The specific vantage points that are offered by the specimen described here are rarely available to students, who instead work with specimens offering an obstructed view resulting from hemisectioning or visually lacking the relation between urogenital structures as occurs during regional dissection.

To summarize, the new dissection approach resulted in an excellent complete male urogenital dissection with vasculature along with an example of a common male pathology, the direct inguinal hernia. The final plastination enables a viewing perspective of the system from any orientation without obstruction while also enforcing the idea that it is a very connected system despite the spatial separation of its integral parts.

Acknowledgements

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