Scarpa's fascia and clinical signs: the role of the membranous superficial fascia in the eponymous clinical signs of retroperitoneal catastrophe.

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BACKGROUND: The membranous superficial fascia (MSF) was described early in the 19th century as was its role in the clinical sign of urethral disruption. Clinical signs of hemorrhage or leakage of pancreatic and biliary fluid into the retroperitoneum, that were described throughout the 20th century, all relied on circumscribed discoloration of the skin of the torso. The objective of this study was to relate the anatomy of MSF to clinical signs of retroperitoneal catastrophe. METHODS: MSF was dissected in the torso of seven embalmed cadavers to note its extent and its attachments. The attachments of MSF were mapped to the areas of skin discoloration that are described in the clinical signs. RESULTS: The well known extent of MSF in the inguinal region, its continuation into the perineum and its attachment to the fascia lata of the thigh were confirmed with our method of dissection. Dissection was continued superiorly, demonstrating continuation of MSF over the entire torso with loose fibrous attachment of MSF to the deep fascia. MSF is firmly adherent to the mid-line of the abdomen except for the umbilicus, to a horizontal line below the clavicles, and laterally in the abdomen to form pockets. The lines of firm adhesion correspond with the borders of the discoloured areas described in the clinical signs. INTERPRETATION: Circumscription of discoloration seen in the eponymous clinical signs of retroperitoneal catastrophe is explained by confinement of coloured retroperitoneal fluid by MSF and its deep attachments.

Priority for the description of the membranous superficial fascia (MSF), also known as the deep membranous layer of the superficial fascia, in the inguinal region is traditionally accorded to Antonio Scarpa (1752–1832), professor of anatomy and surgery at the University of Pavia.[1] One year later, Abraham Colles described anatomical dissections of MSF in the lower abdomen, perineum, penis and scrotum.[2] Colles discussed the clinical implications of the attachments of this fascia in confining extravasated urine from a disrupted membranous urethra. Eponymous clinical signs, such as those named for Thomas Cullen and George Grey Turner are helpful, even today, in making an early diagnosis of certain abdominal catastrophes where blood or blood stained fluid travels from the retroperitoneum to the anterior abdominal wall.[3] In 1966, JA Fox reported blue discoloration of the upper thigh that reminded him of Cullen's and Grey Turner's signs in two patients who died, one of acute pancreatitis and the other of a ruptured aortic aneurysm.[4] In addition, he noticed a distinct horizontal lower limit of discoloration which corresponded to the insertion of MSF into the fascia lata of the thigh, in a manner similar to the limitation of urine spread from a disrupted urethra. Fox tested his attribution of a role for MSF in this sign by observing the spread of methylene blue injected deep to this fascia.

Discoloration of the torso has also been reported in patients with cystic duct leakage of bile into the retroperitoneum following laparoscopic cholecystectomy.[5] In this situation, a lower limit to the discoloration corresponding to that described by Fox was seen as was areas of discoloration equivalent to Cullen's and Grey Turner's sign. Bile staining was seen in the scrotum and penis, areas associated in other eponymous clinical signs.[6] In addition, the chest was discolored with a new easily recognizable upper limit that was a

horizontal line about 2 cm below the clavicles.[5]

These observations suggest that 1) MSF and its attachments play an important role in the eponymous signs of retroperitoneal catastrophe and 2) MSF is not confined to the inguino-perineal region, as previously described, but is also present in the abdomen and chest where it plays a similar role in confining fluid that has traveled from the retroperitoneum. The objective of this study was to relate the anatomy of MSF to the eponymous clinical signs of retroperitoneal catastrophe.

Methods

Electronic (PubMed after 1954 and Index-Catalogue of the Library of the Surgeon-General's Office before 1954) and hand searches were undertaken for original descriptions and reviews of the clinical signs involving discoloration of the skin of the torso. The original reports were studied for acknowledgments of precedence to others and for discussion of the role of MSF.

Cadavers were provided by the Department of Anatomy and Cell Biology, Schulich School of Medicine and Dentistry at the Western University Canada. Seven embalmed cadavers were used for the dissections, ranging in age from 60 to 92. Of the seven, three were male and four were female. Cadavers were selected on the basis of having normal abdominal surface anatomy.

Cadavers were embalmed 48 hours post-mortem. Western University Canada embalming solution (50% ethyl alcohol, 25% propylene glycol, 16% water, 3.5% formaldehyde, 2% Dettol, 2% phenol and 1.5% sodium acetate) was injected in a retrogarde manner through the right femoral artery and left common carotid artery followed by 650 mL of diluted

latex was injected into the cadaver.

Dissection commenced with a midline skin incision from the manubrium to the pubic region. The skin was reflected laterally on both sides to the extent that the lateral sides of the trunk were exposed preserving the underlying fatty layer. The fat was gently swept away with the scalpel to reveal MSF. The superficial surface of MSF was exposed over the entire torso including the axilla and back. In women this required the breasts to be mobilized with the skin. Short incisions were made in MSF 3 cm from the midline so that it could be elevated to expose the deep surface and to assess its attachment to the deep fascia. Attachments were determined to be loose if gentle blunt dissection with the back of the scalpel freed MSF and to be firm if sharp dissection was required. Integrity of MSF as a single sheet was maintained despite sharp dissection. The attachments of MSF were mapped to the skin discoloration described in the clinical signs.

Results

Historical search. Antonio Scarpa's description of MSF is vague in his 1809 hernia monograph.[7] Life-size illustrations included by Scarpa are magnificent but do not identify MSF. An illustration, available here from the 1823 French edition of Scarpa's monograph, shows all the anatomical layers of the abdominal wall in the inguinal region but not MSF.[8] We did find a probable description of MSF in the third memoir (section) which discusses femoral (called crural) hernia in the male. Scarpa describes that 'below the skin' we find 'a layer of condensed substance forming the second covering of the hernia' which adheres to the 'the aponeurosis of the fascia lata'. A little later he describes this layer as being membranous and he believes it has a role in containing this particular

herniation. In 1810, Abraham Colles described detailed methods of dissection to expose MSF in the lower abdomen and the inguino-perineal region including the penis and scrotum.[2] He clearly associated the subcutaneous limitation of urine extravasation from a ruptured urethra with the attachments of MSF.

The first clinical sign of discoloration from retroperitoneal fluid migration was described in 1903 by John Henry Bryant (1868–1906) in a patient with a leaking aortic aneurysm:

> "When blood is extravasated into the abdominal wall, ecchymoses may appear and one case, which I have already mentioned, which blood was effused into the spermatic cord, the scrotum on the same side became ecchymosed."[9]

In 1906, Ransohoff described bile staining of the skin around the umbilicus in a patient with a ruptured common bile duct.[10] Cullen was aware of Ransohoff's report when he saw a patient with ecchymosis of an analogous distribution caused by hemorrhage from an extra-uterine pregnancy.[11] Grey Turner reported ecchymosis of the loins in two patients who subsequently died from hemorrhagic pancreatitis.[12] Variations on these observations have been reported in the century since then. In 1937, Fallis hypothesized that colored fluid migrated from the retroperitoneal space to the skin.[13] Bile staining of the entire scrotum described by Neoptolemos, in 1984, in a patient with retroperitoneal perforation of the duodenum disproved Bryant's assumption that fluid migrated via the spermatic cord.[14] Fox's observation of a limit to discoloration in the thigh suggested that the fluid is confined by MSF.[4] In the most recent description of bile leakage into the retroperitoneum, the volume of migrating fluid was sufficient to stain skin not only in all the areas previously described but also the chest where a new upper horizontal limit

suggests confinement by MSF at an attachment that has not previously been described.[5]

Anatomical dissection. MSF was dissected as a continuous sheet over the entire anterior torso extending from the clavicles down to the perineum (Figure 1). The skin was loosely adherent to the superficial surface of MSF except for a ring, with a diameter of 1 – 2 cm, around the umbilicus where adhesion to the skin was firm (Figure 2). On its deep surface MSF was loosely adherent to the deep fascia except for the midline where it was firmly attached along the whole anterior torso except for the ring around the umbilicus (Figure 2). MSF created two distinct pockets on the lower abdomen that continued into the perineum. Our dissection in this area confirmed the observations made before, most recently by Martin.[15] Inferiorly, MSF was firmly attached to the fascia lata of the thigh bilaterally. As we dissected the deep surface of MSF in a superior direction we found intermediate adherence along the costal margin and firm adherence to the clavi-pectoral fascia just below the clavicles, extending into the upper axilla (Figure 1). Laterally we found MSF to been firmly adherent to the deep fascia of the lumbar muscles. In general deep adherence of MSF to the deep fascia was looser in the abdomen than over the anterior chest. These lines of adherence resulted in two pockets forming in the lateral abdominal wall (Figure 3).

Correlation of dissection with clinical signs. Firm adherence of MSF to the fascia lata of the thigh is clearly responsible for the lower limit of discoloration seen with Fox's sign and with retroperitoneal bile leakage.[4,5] Access for retroperitoneal fluid to the penis and scrotum via the perineum explains the discoloration seen in this area in Bryant's sign and with retroperitoneal bile leakage.[5,9,14] The lateral pockets in the abdomen (Figure 3) are identical to the location of discoloration photographed by Grey Turner.[12] We believe fluid

from the retroperitoneum travels through the umbilical defect in MSF but is then limited by its adherence to a ring of skin giving the characteristic discoloration of Ransohoff and Cullen's sign (Figure 2).[10, 11] If the volume of retroperitoneal fluid that migrates to the space below MSF is sufficient, discoloration may be seen in the upper torso. The horizontal line of firm adherence of MSF to the deep fascia below the clavicle and in the upper axilla gives the characteristic appearance of the upper border of discoloration in this instance (Figure 1).[5]

Discussion

MSF is not confined to the lower abdomen and perineum as commonly believed. We have demonstrated that it extends over whole torso, being most pronounced anteriorly. This finding is consistent with modern radiological studies which find evidence for MSF deep to the skin of the whole body.[17,18] It is interesting to consider the teleological purpose of MSF. Scarpa's assertion that MSF assists in the prevention of hernias has been repeated often but it is not consistent with a modern understanding of hernia.[7, 15] We believe MSF is designed to bind the skin to the body by two layers of attachment on each side of the membranous fascia. This construction supports the skin so that it doesn't sag with gravity but allows it to stretch in a way that does not impede movement. Simply put, MSF is the scaffold of the skin. As such, its role in reconstructive surgery is acknowledged and being investigated in the development of adipofascial flaps.[16]

Much of the previous work regarding retroperitoneal fluid migration and the eponymous clinical signs has tried to determine the route taken by the fluid to the skin.[13,19,20] We believe there are many routes between the peritoneum and MSF, both of which are

impermeable and therefore confine spread of fluid. The characteristic element of the eponymous clinical signs is the limit of discoloration of the subcutaneous layer that is visible through the skin. The lines of firm attachment of MSF explain these limits and thereby the eponymous clinical signs.

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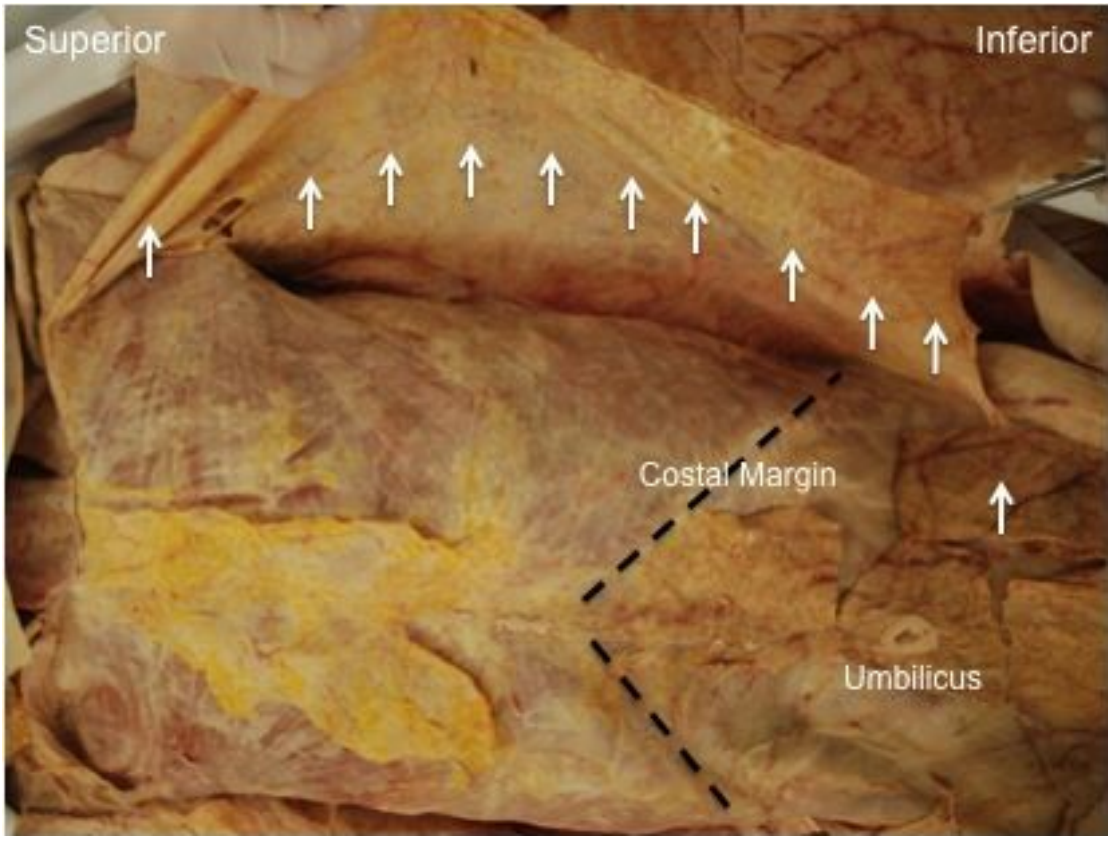
Legends for figures

Figure 1. Dissection of the membranous superficial fascia (MSF) in the upper torso showing its firm attachment to the deep fascia below the clavicle, extending into the upper axilla. This line of attachment corresponds with the upper limit if bile staining seen with retroperitoneal bile leakage. The white arrows show the deep surface of MSF that is being retracted laterally.

Figure 2. The membranous superficial fascia (MSF) is attached a ring of the external oblique aponeurosis (E) around the umbilicus (U, traveling superficially to a ring of skin (S). The tube like structure of MSF acts as a conduit for retroperitoneal fluid which stains a ring of skin in clinical signs described by Ransohoff and Cullen.

Figure 3. The firm attachment (dashed line) of the membranous superficial fascia (M) to the external oblique aponeurosis (E) creates a pocket which corresponds completely with skin discoloration photographed by Grey Turner. The external oblique aponeurosis (E) has been breached in this dissection, exposing the external oblique muscle (EM).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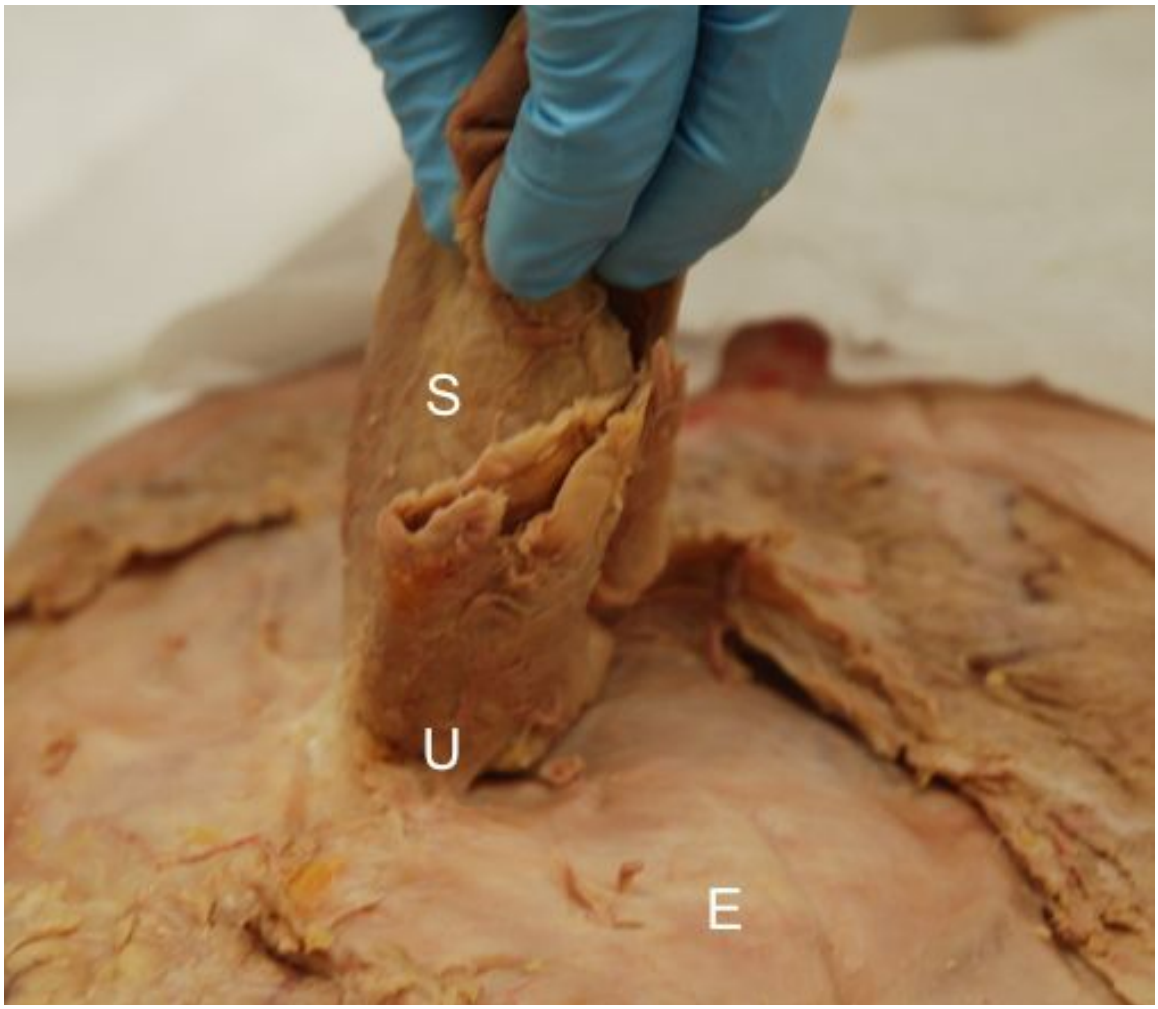
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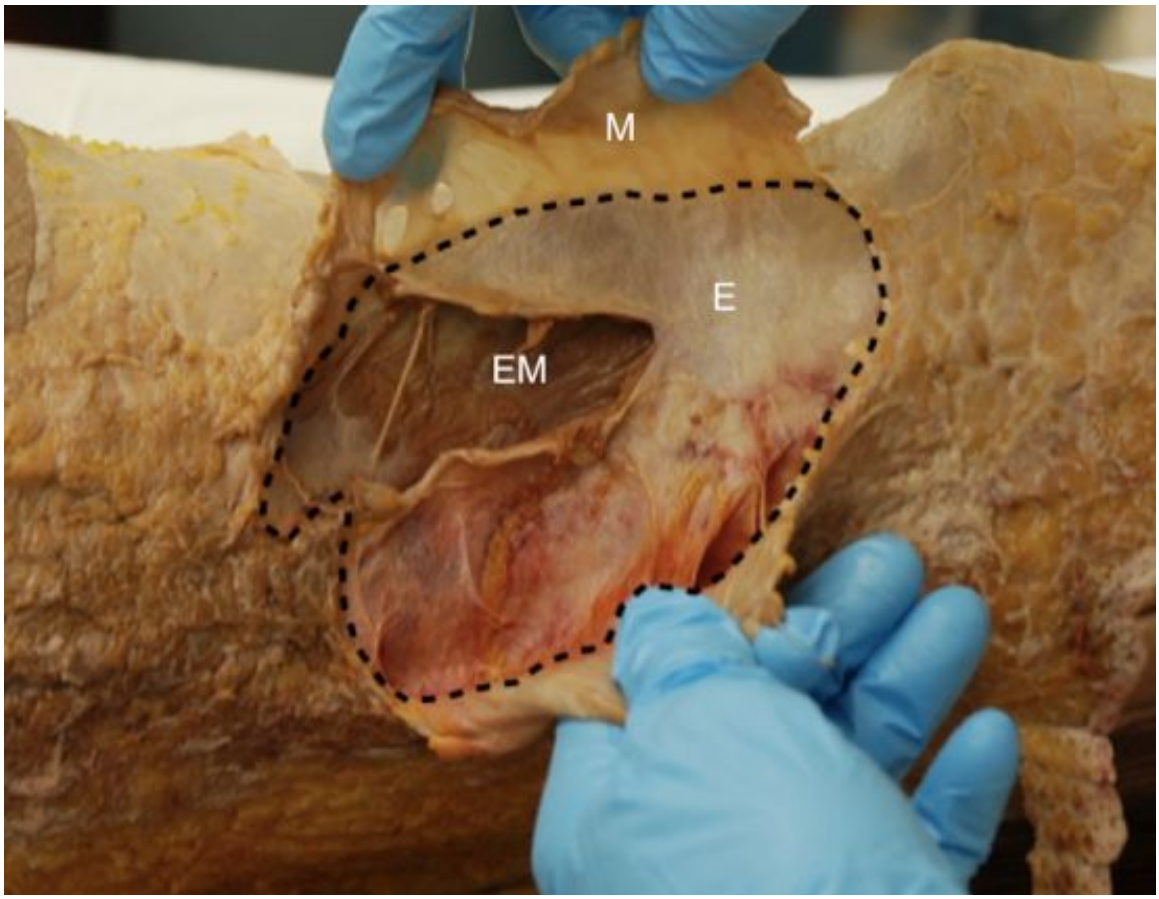
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