

Western University

From the Selected Works of Vivian C. McAlister

October, 2013

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

Shanoor Ullah, *University of Toronto*

Robert Grant, *University of Toronto*

Marjorie Johnson

Vivian C. McAlister

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

SM Ullah, RC Grant, M Johnson, VC McAlister

Canadian Armed Forces and Western University Canada

ABSTRACT

INTRODUCTION 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 haemorrhage or leakage of pancreatic and biliary fluid into the retroperitoneum, which were described throughout the 20th century, all relied on circumscribed discolouration of the skin of the torso. The objective of this study was to relate the anatomy of the MSF to clinical signs of retroperitoneal catastrophe.

METHODS The MSF was dissected in the torso of seven embalmed cadavers to note its extent and its attachments. The attachments of the MSF were mapped to the areas of skin discolouration that are described in the clinical signs.

RESULTS The well known extent of the 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 the MSF over the entire torso with loose fibrous attachment of the MSF to the deep fascia. The MSF is firmly adherent to the midline 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.

CONCLUSIONS Circumscription of discolouration seen in the eponymous clinical signs of retroperitoneal catastrophe is explained by confinement of coloured retroperitoneal fluid by the MSF and its deep attachments.

KEYWORDS

Anatomy – Clinical medicine – Subcutaneous tissue – Pancreatitis – Retroperitoneal space – Hernia

Accepted 26 April 2013

CORRESPONDENCE TO

Vivian McAlister, C4-211, University Hospital, 339 Windermere Road, London, ON, Canada N6A 5A5
T: +1 519 663 2920; E: vmcalist@uwo.ca

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, of Dublin, described anatomical dissections of the 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 Fox reported blue discolouration 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 Furthermore, he no-

ticed a distinct horizontal lower limit of discolouration that corresponded to the insertion of the 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 the MSF in this sign by observing the spread of methylene blue injected deep to this fascia.

Discolouration of the torso has 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 discolouration corresponding to that described by Fox was seen, as were areas of discolouration equivalent to Cullen's and Grey Turner's signs. Bile staining was seen in the scrotum and penis, areas associated in other eponymous clinical signs.⁶ In addition, the chest was discoloured with a new easily recognisable upper limit that was a horizontal line about 2cm below the clavicles.⁵

These observations suggest that: 1) the MSF and its attachments play an important role in the eponymous signs of retroperitoneal catastrophe and 2) the MSF is not confined

to the inguinoperineal region, as described previously, but is also present in the abdomen and chest, where it plays a similar role in confining fluid that has travelled from the retroperitoneum. The objective of this study was to relate the anatomy of the 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 discolouration of the skin of the torso. The original reports were studied for acknowledgements of precedence to others and for discussion of the role of the MSF.

Cadavers were provided by the Department of Anatomy and Cell Biology, Schulich School of Medicine and Dentistry at Western University Canada. Seven embalmed cadavers were used for the dissections, ranging in age from 60 to 92 years. 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 following death. Western University Canada embalming solution (50% ethyl alcohol, 25% propylene glycol, 16% water, 3.5% formaldehyde, 2% Dettol® [Reckitt Benckiser, Slough, UK] 2% phenol and 1.5% sodium acetate) was injected in a retrograde manner through the right femoral artery and left common carotid artery. Following this, 650ml 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 swept away gently with the scalpel to reveal the MSF. The superficial surface of the MSF was exposed over the entire torso including the axilla and back. In women, this required the breasts to be mobilised with the skin.

Short incisions were made in the MSF 3cm 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 the MSF and to be firm if sharp dissection was required. Integrity of the MSF as a single sheet was maintained despite sharp dissection. The attachments of the MSF were mapped to the skin discolouration described in the clinical signs.

Results

Historical search

Antonio Scarpa's description of the MSF is vague in his 1809 hernia monograph.⁷ Lifesize illustrations included by Scarpa are magnificent but do not identify the MSF. An illustration, available from the 1823 French edition of Scarpa's monograph, shows all the anatomical layers of the abdominal wall in the inguinal region but not the MSF.⁸ We did find a probable description of the MSF in the third memoir

(section), which discusses femoral (called crural) hernias in the male.⁷ Scarpa describes that 'below the skin' we find 'a layer of condensed substance forming the second covering of the hernia', which adheres to 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 the MSF in the lower abdomen and the inguinoperineal region including the penis and scrotum.² He clearly associated the subcutaneous limitation of urine extravasation from a ruptured urethra with the attachments of the MSF.

The first clinical sign of discolouration 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 anterior abdominal wall ecchymoses may appear, and in one case which I have already mentioned, in which blood was effused into the spermatic cord, the scrotum on the same side became much 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 haemorrhage from an extrauterine pregnancy.¹¹ Grey Turner reported ecchymosis of the loins in two patients who subsequently died from haemorrhagic pancreatitis.¹²

Variations on these observations have been reported in the century since then. In 1937 Fallis hypothesised that coloured fluid migrated from the retroperitoneal space to the skin.¹⁵ 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 discolouration in the thigh suggested that the fluid is confined by the 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 described previously but also the chest, where a new upper horizontal limit suggests confinement by the MSF at an attachment that has not been described previously.⁵

Anatomical dissection

The MSF was dissected as a continuous sheet over the entire anterior torso extending from the clavicles down to the perineum (Fig 1). The skin was loosely adherent to the superficial surface of the MSF except for a ring, with a diameter of 1–2cm, around the umbilicus, where adhesion to the skin was firm (Fig 2). On its deep surface, the MSF was loosely adherent to the deep fascia except for the midline, where it was attached firmly along the whole anterior torso except for the ring around the umbilicus (Fig 2). The 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

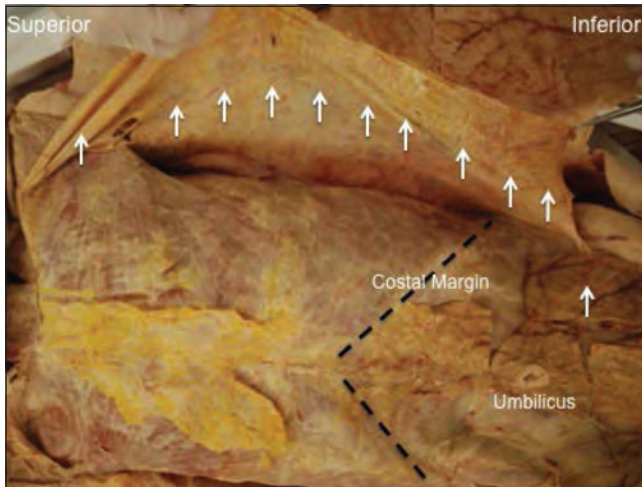


Figure 1 Dissection of the membranous superficial fascia (MSF) in the upper torso showing its firm attachment to the deep fascia below the clavicle, extending into the upper axilla. This line of attachment corresponds with the upper limit if bile staining is seen with retroperitoneal bile leakage. The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

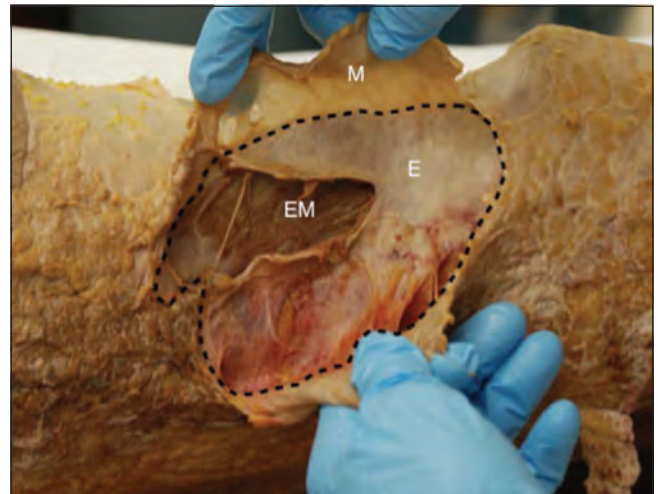


Figure 3 The firm attachment (dashed line) of the membranous superficial fascia (M) to the external oblique aponeurosis (E) creates a pocket that corresponds completely with skin discoloration photographed by Grey Turner. The external oblique aponeurosis (E) has been breached in this dissection, exposing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



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

Inferiorly, the MSF was attached firmly to the fascia lata of the thigh bilaterally. As we dissected the deep surface of the MSF in a superior direction, we found intermediate adherence along the costal margin and firm adherence to the clavipectoral fascia just below the clavicles, extending into the upper axilla (Fig 1). Laterally, we found the MSF to be

firmly adherent to the deep fascia of the lumbar muscles. In general, deep adherence of the 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 (Fig 3).

Correlation of dissection with clinical signs

Firm adherence of the 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 (Fig 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 the MSF but is then limited by its adherence to a ring of skin giving the characteristic discoloration of Ransohoff and Cullen's sign (Fig 2).^{10,11} If the volume of retroperitoneal fluid that migrates to the space below the MSF is sufficient, discoloration may be seen in the upper torso. The horizontal line of firm adherence of the 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 (Fig 1).⁵

Discussion

The MSF is not confined to the lower abdomen and perineum as commonly believed. We have demonstrated that it extends over the whole torso, being most pronounced anteriorly. This finding is consistent with modern radiological

studies, which find evidence for the MSF deep to the skin of the whole body.^{17,18}

It is interesting to consider the teleological purpose of the MSF. Scarpa's assertion that the MSF assists in the prevention of hernias has been repeated often but it is not consistent with a modern understanding of hernias.^{7,15} We believe the 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 does not sag with gravity but allows it to stretch in a way that does not impede movement. Simply put, the MSF is the scaffold of the skin. As such, its role in reconstructive surgery is acknowledged and is being investigated in the development of adipofascial flaps.¹⁶

Conclusions

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.^{15,19,20} We believe there are many routes between the peritoneum and the MSF, both of which are impermeable and therefore confine the 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 the MSF explain these limits and thereby the eponymous clinical signs.

References

- Parigi AB. Antonio Scarpa was an outstanding 'head' in the history of surgery. *Am J Surg* 2004; **188**: 17–21.
- Colles A. *A Treatise on Surgical Anatomy*. Dublin: Gilbert & Hodges; 1811.
- Mookadam F, Cikes M. Cullen's and Turner's signs. *N Engl J Med* 2005; **353**: 1,386.
- Fox JA. A diagnostic sign of extraperitoneal haemorrhage. *Br J Surg* 1966; **53**: 193–195.
- McAlister VC, Sener A. Demarcated truncal jaundice: a sign of retroperitoneal bile leakage. *Ann Intern Med* 2005; **142**: 389.
- Sotos JG. Cullen's and Turner's signs. *N Engl J Med* 2006; **354**: 979.
- Scarpa A. *Sull' ernie: memoire anatomico-chirurgiche*. Milano: Stamperia Reale; 1809.
- Scarpa A. *Traité Pratique des Hernies*. Paris: Gabon; 1823. Plate II. <http://www.library.utoronto.ca/anatomical/RBA1058/0005-0-0.jpg> (cited July 2013).
- Bryant JH. Two clinical lectures on aneurysm of the abdominal aorta. Lecture I. *Clin J* 1903; **23**: 71–80.
- Ransohoff J. Gangrene of the gall bladder. Rupture of the common bile duct, with a new sign. *JAMA* 1906; **45**: 395–397.
- Cullen TS. A new sign in ruptured extrauterine pregnancy. *Am J Obstet Gynecol* 1918; **78**: 457.
- Grey Turner G. Local discoloration of the abdominal wall as a sign of acute pancreatitis. *Br J Surg* 1919; **7**: 394–395.
- Fallis LS. Cullen's sign in acute pancreatitis. *Ann Surg* 1937; **106**: 54–57.
- Neoptolemos JP, Harvey MH, Slater ND, Carr-Locke DL. Abdominal wall bile staining and 'biliscrotum' after retroperitoneal perforation following endoscopic sphincterotomy. *Br J Surg* 1984; **71**: 684.
- Martin BF. The formation of abdomino-perineal sacs by the fasciae of Scarpa and Colles, and their clinical significance. *J Anat* 1984; **138**: 603–616.
- Worseg AP, Kuzbari R, Hübsch P *et al*. Scarpa's fascia flap: anatomic studies and clinical application. *Plast Reconstr Surg* 1997; **99**: 1,368–1,380.
- Chopra J, Rani A, Rani A *et al*. Re-evaluation of superficial fascia of anterior abdominal wall: a computed tomographic study. *Surg Radiol Anat* 2011; **33**: 843–849.
- Abu-Hijleh MF, Roshier AL, Al-Shboul Q *et al*. The membranous layer of superficial fascia: evidence for its widespread distribution in the body. *Surg Radiol Anat* 2006; **28**: 606–619.
- Raptopoulos V, Kleinman PK, Marks S *et al*. Renal fascial pathway: posterior extension of pancreatic effusions within the anterior pararenal space. *Radiology* 1986; **158**: 367–374.
- Oliphant M, Berne AS, Meyers MA. The subperitoneal space of the abdomen and pelvis: planes of continuity. *Am J Roentgenol* 1996; **167**: 1,433–1,439.