© 2018 EDIZIONI MINERVA MEDICA
Online version at http://www.minervamedica.it

Minerva Anestesiologica 2019 January;85(1):15-20
DOI: 10.23736/S0375-9393.18.12479-5

ORIGINAL ARTICLE

Blocking around the *transversalis fascia*: behind the scene

Francesco VASQUES [1] *, Carla STECCO [2], Raffaele MITRI [1],
Raffaele DE CARO [2], Pierfrancesco FUSCO [3], Astrid U. BEHR [4]

[1]Unit of Anesthesia and Intensive Care, Department of Medicine (DIMED), University Hospital of Padua, Padua, Italy; [2]Department of Neuroscience, Institute of Anatomy, University of Padua, Padua, Italy; [3]Department of Anesthesia and Intensive Care Unit, San Salvatore Academic Hospital of L'Aquila, L'Aquila, Italy; [4]Institute of Anesthesia and Resuscitation, University Hospital of Padua, Padua, Italy

*Corresponding author: Francesco Vasques, via Cesare Battisti 267, 35121 Padua, Italy. E-mail: francesco.vasques@hotmail.it

ABSTRACT

BACKGROUND: The *transversalis fascia* plane and the *quadratus lomborum* blocks target the branches of T12-L1 nerves and provide analgesia in patients undergoing surgery involving the corresponding dermatomes. The transversalis fascia is believed to contribute to determine the spread of local anesthetic in such blocks. Nonetheless, the anatomy of this fascia and its possible role in these blocks still have to be precisely defined.
METHODS: We conducted a series of 10 dissections and full-thickness specimens were obtained from one side for the microscopic analysis.
RESULTS: Macroscopic study showed failed to identify a distinguishable fascial structure between the fascia of the *transversus abdominis* muscle and the peritoneum. Microscopic examination showed the presence of a further fascial layer (0.1-0.2 mm), ascribable to transversalis fascia. Transversalis fascia and *transversus abdominis* epimysium posteriorly diverge: *transversus epimysium* goes posteriorly to *quadratus lomborum* to joint the oblique internal aponeurosis, while *transversalis fascia* continues in front to *quadratus lomborum*. So, a little fascial triangle (2-3 mm) is formed on the lateral border of *quadratus lomborum*, defined by transversalis fascia and *transversus abdominis*. Inside this triangle, T12 and L1 nerves are present.
CONCLUSIONS: Considering the thinness of the transversalis fascia and the small size of the triangular space that contains the target nerves, this is most likely a virtual, ideal rather than realistic injection site. Accordingly, it is probable that the local anesthetic is injected in the much wider retroperitoneal space and reaches the nerves by spreading backwards through the thin transversalis fascia.

(Cite this article as: Vasques F, Stecco C, Mitri R, De Caro R, Fusco P, Behr AU. Blocking around the *transversalis fascia*: behind the scene. Minerva Anestesiol 2019;85:15-20. DOI: 10.23736/S0375-9393.18.12479-5)

KEY WORDS: Nerve block - Abdominal wall, anatomy and histology - Fascia.

Trunk blocks of the abdominal wall became part of multimodal analgesia for patients undergoing abdominal surgery.[1, 2] The *transversalis fascia* plane (TFP) block[3] and the *quadratus lomborum* blocks (QLBs) target the subcostal (T12), ilioinguinal and iliohypogastric (L1) nerves proximally, deep to the trans*versus* abdominis muscle and around the *quadratus lomborum* muscle, in order to involve also their lateral cutaneous branches.[3-5] These blocks are currently indicated in patients undergoing anterior iliac crest harvesting as well as inguinal hernia repair, open appendectomy and other procedures involving T12-L1 dermatomes.[3, 6, 7] The nomenclature of such blocks is partly ambiguous. In particular, the injection site of the TFP appears to be the same described for the QLB1, also referred to as lateral QLB.[8, 9] In clinical practice, according also to our experience, this block can require relatively high volume of local anesthetics (0.2-0.3 mL/kg) and often provides more analgesia than anesthesia.[9] The transversalis fascia is believed to play an important role in the spread of local anesthetic in such blocks and the exact compartment in which the local anesthetic is injected must be defined accordingly.[3, 6] The transversalis fascia was first described as a thin fascia, immediately behind the abdominal muscles.[10] Thereafter, it was referred to as the aponeurosis of the *transversus abdominis* muscle and not a different, separable structure.[11] Also its microscopic aspect is described in different ways: as a fibrous membrane, as a layer of fatty tissue or as a border lamella of the peritoneum.[12] Anatomy atlases and textbooks are frequently elusive on the anatomy of the deep posterior abdominal wall, especially regarding the transversalis fascia, while cadaver studies based on dye injection yielded inconsistent results regarding the spread of the injected mean.[13]

Our aim was to study the fascial anatomy of the TFP and QLB blocks site, with special focus on the *transversalis fascia*, its relation with T12 and L1 branches and its potential role in such blocks.

Materials and methods

We conducted a series of 10 dissections of unembalmed cadavers, obtained from the Body Donation Program at the Anatomy Institute of the Padua University.[14] Dissections were performed between March and December 2015 through a posterior (N.=6) or anterior (N.=4) approach. In the first 6 cases, the posterior access to the abdominal wall was obtained via a longitudinal dorso-lateral incision running from rib 12 to the ilium, approximately 5 cm lateral to the spinous processes. The skin and subcutaneous tissue were removed, exposing the external oblique muscle, part of the serratus anterior muscle and of the latissimus dorsi. Advancing in cranio-caudal direction, we progressively dissected the external and the internal obliques, isolating the connective layers surrounding each muscle (epimysium). Through the dissection of the internal oblique, we exposed the plane of the trans*versus* abdominis and the nerves running herein (Figure 1A). Furthermore, we proceeded antero-posteriorly along the cleavage plane between the *transversus abdominis* muscle and the parietal peritoneum up to the lateral edge of the *quadratus lomborum* muscle (Figure 1B). In the second dissection group, a xipho-pubic incision was used to access the abdominal cavity. We removed the omental fat, the digestive tract from the stomach to the rectum, the mesenteric sheet and the liver. We exposed the right retroperitoneal space and reached the TFP site (Figure 2). Irrespective of the approach, one side of abdominal wall of each cadaver was used for macroscopic dissection while the opposite side provided a full-thickness sample that included the TFP block site that was processed for microscopic examination. Three different histological stains were used: hematoxylin-eosin, van Gieson for elastic fibers and azan Mallory for collagen fibers. Besides, the immunohistochemical stain anti-S100 was used to identified the nerves. Computerized microscope measures of the examined structures were obtained with the Image-J Leica Microsystem software (Leica, Germany).

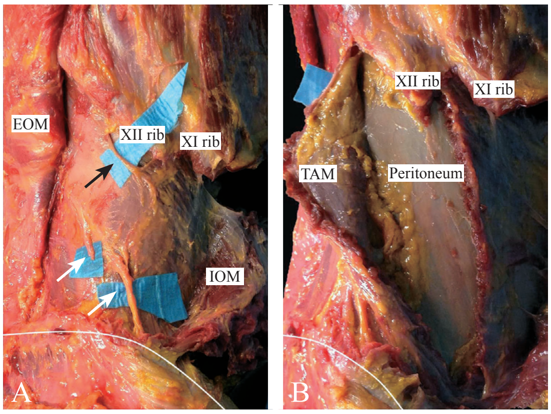

Figure 1.—A) Macrosection of the right side of the prone body showing some abdominal nerves crossing the *transversus abdominis* plane (TAP). To show this plane, we dissected and mobilized both the EOM and the IOM. B) Plane between the transversus abdominis and the parietal peritoneum. White line, iliac crest; white arrows, ileoinguinal and ileohypogastric nerves; black arrow, subcostal nerve.
EOM: external oblique muscle; IOM: internal oblique muscle; TAM: transversus abdominis muscle.

Results

Macroscopic study

In the first dissection group, the section and dislocation of the *transversus abdominis* revealed the parietal peritoneum (anteriorly) and the renal lodge (posteriorly). As expected, the *transversus abdominis* was entirely covered by its epimysium, that was closely attached to the muscle. Between the *transversus abdominis* and the peritoneum, it was impossible to identify or dissect any further fascial plane (Figure 1). Along the lateral margin of the quadratus lomborum muscle, the ilioinguinal and iliohypogastric nerves were identified in all the dissections running between the *transversus abdominis* and its fascia. More anteriorly, these nerves crossed the *transversus abdominis* entering the TAP with an antero-lateral direction.

In the second group, in the retroperitoneal space, the renal fascia was clearly evident. Its anterior layer (Gerota fascia) passes medially, front the renal vessels, aorta and inferior vena cava to continue with the same fascia of the contralateral side, while the posterior layer (Zuckerckandl fascia) fuses with the prevertebral fascia, separating in this way the retrorenal space of the two sides (Figure 2). After having removed the Zuckerckandl fascia, the posterior abdominal wall was visualized, with the *transversus abdominis*, the *quadratus lomborum* and the iliopsoas muscles. All these muscles were covered by a thin fascial layer, strongly adherent to them. The iliohypogastric and ilioinguinal nerves appeared laterally to the *quadratus lomborum* and then running on the surface of the *transversus abdominis*, covered by a thin fascia. Between the epymisia of such muscles and the Zuckerckandl fascia, only lose connective tissue was identifiable.

Microscopic study

At the microscopic analysis, two different fascial layers covered the abdominal aspect of the trans*versus* abdominal muscle, one attributed to the epimysium of the trans*versus* abdominis, one to the transversalis fascia. The two fascial layers presented different features: regarding the transversalis fascia, its thickness varied from 0.1 to 0.2 mm and it was rich in elastic fibers at the Van Gieson staining; conversely, the epimysium of the trans*versus* abdominis was thicker, ranging from 0.2 mm to 1.6 mm, had a small amount of elastic fibers and only in its external, muscular aspect and in proximity of its aponeurosis (Figure 3). Advancing posteriorly toward the *quadratus lomborum*, the two fibrous structures split: the *transversus abdominis* epimysium goes posteriorly to the *quadratus lomborum* muscle to join the internal oblique aponeurosis forming the anterior layer of the thoracolumbar fascia, while the *trandversalis fascia* continues in front to the *quadratus lomborum* muscle. So, a little fascial triangle (2-3 mm) is formed on the lateral border of the *quadratus lomborum*, defined by the transversalis fascia and the trans*versus* abdomi-

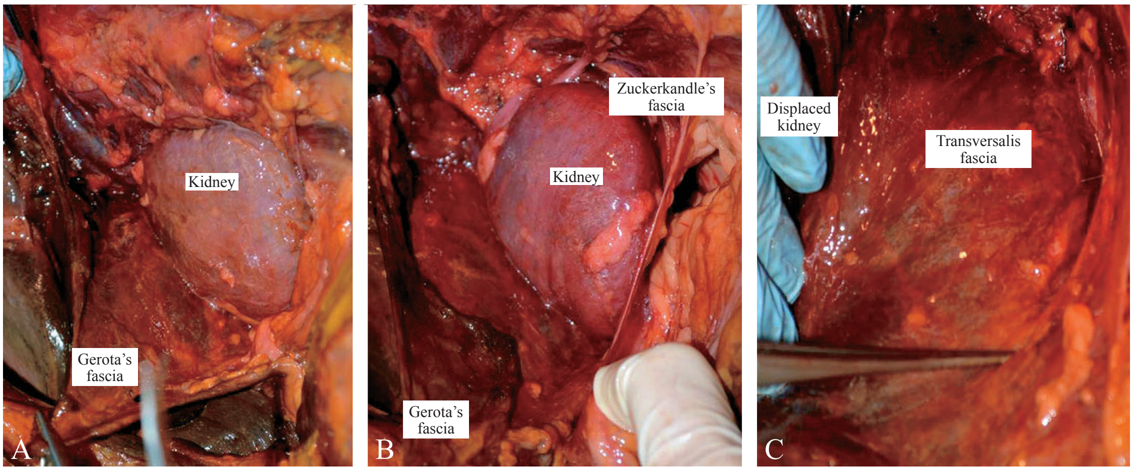

Figure 2.—Macrosection. A) Gerota's fascia is abducted to show the kidney; B) the kidney is mobilized, showing the posterior Zuckerkandle's fascia; C) the kidney is displaced medially, the Zuckerkandle's fascia is removed showing the retrorenal space and the inner aspect of the abdominal wall (*transversalis fascia* adherent to the epymisium of the *transversus abdomins* muscle).

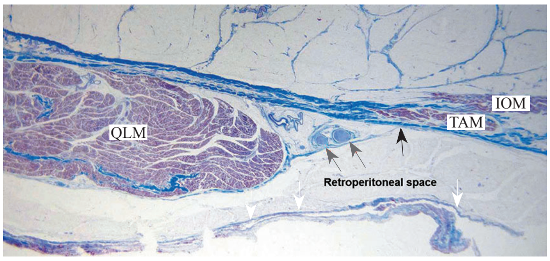

Figure 3.—Microsection, Azan-Mallory staining; original magnification 12X.
IOM: internal oblique muscle; TAM: *transversus abdominis* muscle; QLM: *quadratus lomborum* muscle; Black arrow, point where the *transversalis fascia* separates from the epymisium of the TAM; Red arrows, triangular space behind circumscribed by the *transversalis fascia*, the QLM and the TAM, containing the branches of T12 and L1 surrounded by loose connective tissue; white arrows, parietal peritoneum.

nis (Figure 3). Inside this triangle, some nerves with a thickness ranging between 0.6 to 0.8 mm and loose connective tissue were always present. We identified these nerves as the branches of the subcostal (T12), ileoinguinal and ileohypogastric (L1) nerves. Beyond the transversalis fascia, we could identify the posterior layer of the renal fascia (Figure 4). The space between these two structures was filled with fat tissue and its depth ranged between 4 and 5 mm.

Discussion

The aim of this study was to contribute to the anatomical understanding of fascial anatomy surrounding the site of injection for the blocks around

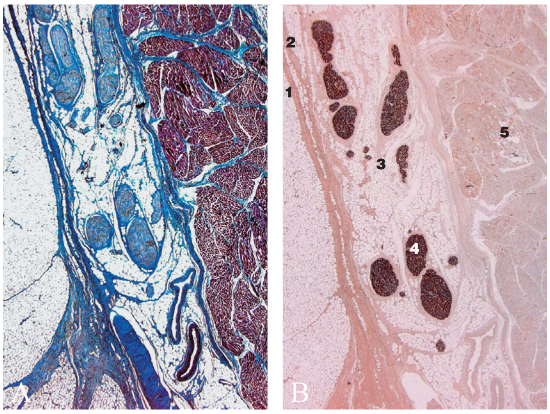

Figure 4.—Microsections, original magnification 20X. 1, parietal peritoneum; 2, *transversalis fascia*; 3, loose connective tissue; 4, nerve branches; 5, *quadratus lomborum* muscle. A Van Gieson staining; B Immuno S100 staining.

the quadratus lomborum muscle, in particular the TFP block, considering the lack of univocity of both the nomenclature of such blocks and the fascial anatomy of the posterior abdominal wall.[8] With histological staining we demonstrated that the transversalis fascia exists. Nonetheless, it is very thin and closely adherent to the fascia of the *transversus abdominis* (*i.e.* they are macroscopically inseparable), except laterally to the quadratus lomborum, where the two structures bounder a little triangle that contains the iliohypogastric and ilioinguinal nerves (Figure 3). In our opinion, this triangle could be considered the *ideal injection site* for the TFP block, being most likely able to strictly compartmentalize the anesthetic drugs around the target nerves. Indeed, if this was the case, a very little volume of local anesthetic inundating a small space might be effective in blocking the iliohypogastric and ilioinguinal branches and a rapid-onset, anesthetic effect as well as a specific cutaneous correspondence may be expected.[3, 15] Really, the scarce dimension of this triangle and the thinness of the transversalis fascia allow us to consider this site more as a virtual than a real target. Indeed, it appears more likely that the needle tip regularly crosses the transversalis fascia during the performance of such blocks eventually causing the spread of the anesthetic drug in the much wider retroperitoneal space, as recently reported by Choquet and Capdevila.[16] If this is the case, the local anesthetic must reach the target nerves spreading backward, through the transversalis fascia. Therefore, more volume is likely required and an analgesic rather than anesthetic effect is obtained, with variable magnitude, extension and onset time.[17] In clinical practice, some authors claim that a very distinct tactile and visual (*i.e.* ultrasound) "pop" occurs when the needle goes through the transversalis fascia.[7] In our experience this is not always true, probably due to the scares thickness of this structure. Nonetheless, ultrasound visualization of the local anesthetic spreading between the transversalis fascia and the retroperitoneal tissue may be valuable to confirm the correct placement of the needle tip.

Limitations of the study

The most relevant limitation of this analysis is inherent to cadaver studies, where anatomical structures may have different dimensions and mutual relations when compared to the living subject. Therefore, the dimensions we described in our series might be different from those found in clinical practice. Second, we did not perform dye injection in this series of cadaver dissections. Besides the intrinsic limitations of performing dye diffusion in cadavers, which may be affected by the same issues mentioned above and which yielded inconsistent results,[18] here we wanted to study the fascial anatomy of this anatomical region and we preferred to avoid the risk of altering it with any invasive maneuver before the dissection. Nevertheless, doing so, we missed potentially useful data regarding the pattern of distribution of an injected dye or contrast medium and the possible alteration of anatomy that may follow the injection.

Conclusions

This anatomical study showed that the *transversalis fascia* in the posterior abdominal wall is a very thin, non-separable structure that contributes to delimit a tiny triangular space where the iliohypogastric and ileoinguinal nerves are located in the proximity of the *transversus abdominis* and the *quadratus lomborum* muscles. The thinness of the fascia, as evidenced by the microscopic examination, most likely explains why relatively large volumes of local anesthetic injected in the adjacent and more easily targeted retrorenal space produce a successful analgesic effect after TFP/QLB 1 performance. We believe that further studies may address the imaging (*e.g.* ultrasound) anatomy of the *transversalis fascia*, particularly in the living model, contributing to understanding the diffusion pattern and the volume of local anesthetic required to achieve the desired effects.

What is known

- The *transversalis fascia* is believed to contribute to the distribution of the local anesthetic during the performance of the transversalis fascia plane block.
- The fascial anatomy of the posterior abdominal wall, however, is not completely understood and the anatomical rationale for its role in the transversalis fascia plane block remains unclear.

What is new

- Although histologically different, the transversalis fascia is macroscopically inseparable from the *transversus abdominis* muscle aponeurosis in the posterior abdominal wall.
- Laterally to the *quadratus lomborum* muscle, the two structures separate identifying a triangle, which contains the ilioinguinal and iliohypogastric nerves and might be the ideal site for local anesthetic injection for the transversalis fascia plane block.

References

1. Baeriswyl M, Kirkham KR, Kern C, Albrecht E. The Analgesic Efficacy of Ultrasound-Guided Transversus Abdominis Plane Block in Adult Patients: A Meta-Analysis. Anesth Analg 2015;121:1640–54.

2. McDonnell JG, Curley G, Carney J, Benton A, Costello J, Maharaj CH, *et al.* The analgesic efficacy of transversus abdominis plane block after cesarean delivery: a randomized controlled trial. Anesth Analg 2008;106:186–91.

3. Hebbard PD. Transversalis fascia plane block, a novel ultrasound-guided abdominal wall nerve block. Can J Anaesth 2009;56:618–20.

4. Chiono J, Bernard N, Bringuier S, Biboulet P, Choquet O, Morau D, *et al.* The ultrasound-guided transversus abdominis plane block for anterior iliac crest bone graft postoperative pain relief: a prospective descriptive study. Reg Anesth Pain Med 2010;35:520–4.

5. Jamieson RW, Swigart LL, Anson BJ. Points of parietal perforation of the ilioinguinal and iliohypogastric nerves in relation to optimal sites for local anaesthesia. Q Bull Northwest Univ Med Sch 1952;26:22–6.

6. Chin KJ, Chan V, Hebbard P, Tan JS, Harris M, Factor D. Ultrasound-guided transversalis fascia plane block provides analgesia for anterior iliac crest bone graft harvesting. Can J Anaesth 2012;59:122–3.

7. Chin KJ, McDonnell JG, Carvalho B, Sharkey A, Pawa A, Gadsden J. Essentials of Our Current Understanding: Abdominal Wall Blocks. Reg Anesth Pain Med 2017;42:133–83.

8. El-Boghdadly K, Elsharkawy H, Short A, Chin KJ. Quadratus Lumborum Block Nomenclature and Anatomical Considerations. Reg Anesth Pain Med 2016;41:548–9.

9. Ueshima H, Otake H, Lin JA. Ultrasound-Guided Quadratus Lumborum Block: An Updated Review of Anatomy and Techniques. BioMed Res Int 2017;2017:2752876.

10. Cooper AP. The Anatomy and Surgical Treatment of Abdominal Hernia; London: Longman; 1804.

11. Skandalakis PN, Zoras O, Skandalakis JE, Mirilas P. Transversalis, endoabdominal, endothoracic fascia: who's who? Am Surg 2006;72:16–8.

12. Memon MA, Quinn TH, Cahill DR. Transversalis fascia: historical aspects and its place in contemporary inguinal herniorrhaphy. J Laparoendosc Adv Surg Tech A 1999;9:267–72.

13. Carney J, Finnerty O, Rauf J, Bergin D, Laffey JG, Mc Donnell JG. Studies on the spread of local anaesthetic solution in transversus abdominis plane blocks. Anaesthesia 2011;66:1023–30.

14. Porzionato A, Macchi V, Stecco C, Mazzi A, Rambaldo A, Sarasin G, *et al.* Quality management of Body Donation Program at the University of Padova. Anat Sci Educ 2012;5:264–72.

15. López-González JM, López-Álvarez S, Jiménez Gómez BM, Areán González I, Illodo Miramontes G, Padín Barreiro L. Ultrasound-guided transversalis fascia plane block versus anterior transversus abdominis plane block in outpatient inguinal hernia repair. Rev Esp Anestesiol Reanim 2016;63:498–504.

16. Choquet O, Capdevila X. Quadratus Lumborum 1 and Transversalis Fascia Blocks: Different Names for the Same Posterior Pararenal Space Block. Reg Anesth Pain Med 2017;42:547–8.

17. Murouchi T, Iwasaki S, Yamakage M. Quadratus Lumborum Block: Analgesic Effects and Chronological Ropivacaine Concentrations After Laparoscopic Surgery. Reg Anesth Pain Med 2016;41:146–50.

18. Dam M, Moriggl B, Hansen CK, Hoermann R, Bendtsen TF, Børglum J. The Pathway of Injectate Spread With the Transmuscular Quadratus Lumborum Block: A Cadaver Study. Anesth Analg 2017;125:303–12.

Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions.—Francesco Vasques: dissections, data interpretation, text writing and revision, figure preparation; Carla Stecco: dissections and histology, data interpretation, text revision; Raffaele Mitri: dissections, text writing and figure preparation; Raffaele De Caro: text revision; Pierfrancesco Fusco: text revision; Astrid U. Behr: data interpretation, text writing and revision.

Acknowledgements.—The authors are grateful to Dr. Anna Rambaldo, Martina Sfriso and Gloria Sarasin for the technical assistance.

Article first published online: March 27, 2018. - Manuscript accepted: March 6, 2018. - Manuscript revised: February 5, 2018. - Manuscript received: October 3, 2017.