CLINICAL ORTHOPAEDICS AND RELATED RESEARCH
Number 363, pp 203–211

Obturator Neuropathy

An Anatomic Perspective

Gregory Harvey, MB, BS; and Simon Bell, MB, BS***

Entrapment of the anterior division of the obturator nerve is a recently described cause of medial groin pain. This anatomic study examines the extrapelvic course of the nerve and related fascia in the adductor region to provide an anatomic basis for the syndrome and to aid in surgical treatment. Twelve anatomic specimen limbs were dissected to document the extrapelvic course of the obturator nerve, the myofascial arrangement, and the vasculature. A thirteenth limb was prepared with intraarterial glycerin to examine the vessels in more detail. A distinct fascial plane was found deep to the adductor longus and pectineus overlying the anterior division of the obturator nerve. The arterial supply to the adductor muscles is related intimately to the nerve and its branches, with associated local thickening of the fascial connective tissue. The relationship between the nerve, vessels, and fascia appears sufficient to result in an entrapment syndrome. The anatomic findings from this series will help plan the surgical treatment of this condition.

Chronic pain in the groin region is a difficult clinical problem to evaluate, and in many cases the cause of the pain is poorly understood. Possible causative clinical syndromes in affected areas include tendinitis, bursitis, osteitis, stress fracture, hernias, conjoint tendon strains, inguinal ligament enthesopathy, and entrapment of the lateral cutaneous nerve of the thigh.[1,7,11]

Numerous operative treatment modalities have been described for the various conditions, including adductor tenotomy, rectus abdominis tenotomy, and herniorrhaphy.[1,7,11] These procedures have in some instances produced reasonable results, yet there remains a group of patients without a clearly defined disease and unsatisfactory treatment outcome. In particular there have been poor results with patients who have pain in the adductor region. Compression of the anterior division of the obturator nerve in the thigh has been described recently as one possible cause for adductor region pain, and entrapment of this nerve has been documented by nerve conduction studies.[2] Promising early

From the Departments of Orthopaedic Surgery, *Austin and Repatriation Hospitals, Heidelberg, Victoria, Australia; and **Monash Medical Centre, Clayton, Victoria, Australia.

Work performed at the Department of Anatomy and Cell Biology, University of Melbourne, Parkville, Victoria, Australia.

Reprint requests to Gregory Harvey, MB, BS, 46 Hoffmans Road, Essendon, Victoria, Australia 3040.

Received: June 10, 1997.

Revised: June 2, 1998; October 13, 1998.

Accepted: November 4, 1998.

results have been reported with surgical decompression of the anterior division of the obturator nerve.[2]

The senior author (SB) has found during numerous obturator nerve decompressions marked variability in the anatomy of the nerve, vasculature, and the myofascial pattern, which has not been well documented. There is considerable information concerning the intrapelvic and extrapelvic courses of the obturator nerve in the current literature,[3,4,6,10] but it is sparse with respect to the fascial planes in the adductor region of the thigh, in particular that region between the adductor brevis and the overlying adductor longus and pectineus. The overall literature concerning the extrapelvic course of the obturator nerve is not detailed enough to help adequately with the operative procedure of obturator nerve decompression. The current anatomic study was undertaken to increase the knowledge of the anatomy in this region. Special attention is given to the fascial development overlying the nerve to assess how it could result in entrapment, the vasculature encountered during the approach to the anterior division of the obturator nerve, and variations in the final course of the anterior division of the obturator nerve.

MATERIALS AND METHODS

Twelve limbs from seven cadavers (two unilateral only) were dissected. The cadavers were preserved with a mixture of formaldehyde and ethanol by embalming within 3 to 7 days of death with a mixture of 0.9 L 40% formaldehyde, 6.0 L glycerin, 500 g phenol in 0.9 L ethanol, and 160 g NaCl in 4.2 L water. The cadavers were stored in vacuum bags at 4° C for 1 to 2 years. An identical dissection sequence was used in all specimens studied. All superficial fascia was removed over the anteromedial thigh to expose fascia lata. The sartorius was detached from its proximal attachment, and the femoral triangle was dissected free to reveal the pectineus and adductor longus lying deep to the medial intermuscular septum. A longitudinal incision was made over the adductor longus and extended proximally. The pelvic attachment of adductor longus was detached from bone, and the muscle was separated from the fascia beneath with blunt finger dissection. The neurovascular bundles were detached at the muscle surface to preserve this fascial plane. The pectineus was detached from its origin and bluntly dissected in a similar manner to expose the continuation of this fascia. At each level, the vascular arrangements encountered were observed.

One limb from a male cadaver preserved in the same mixture was prepared to allow unilateral dissection of vessels encountered during one surgical approach to the nerve. The external iliac artery was cannulated, and glycerin dyed with red and blue writing ink was injected under pressure. Each layer passed through during surgery was dissected to show the vascular pattern, and a photographic record was kept at each stage.

RESULTS

Myofascial Pattern

The fascial plane separating the pectineus and adductor longus from the underlying adductor brevis consisted of a thin, but very definite, layer of connective tissue with variable amounts of fat, in proportion to the obesity of the cadaveric limb, with condensations around the vessels. In all limbs there was a well defined fascial layer that could be dissected from the perineurium of the nerve. The presence of fat and condensations of connective tissue around vessels, combined with the vascular nature of this intermuscular layer, gave the fascia a thickened appearance. This was particularly apparent where a branch of the medial circumflex femoral artery ramifies to supply the muscles in this region. When the fat was removed from between the vessels, the connective tissue component of the layer is thinner than the medial intermuscular septum of the same limb (Figs 1, 2).

In one limb there was no distinct interval found between the adductors longus and brevis and the pectineus, with the muscles appearing as a continuous sheet, underlying a

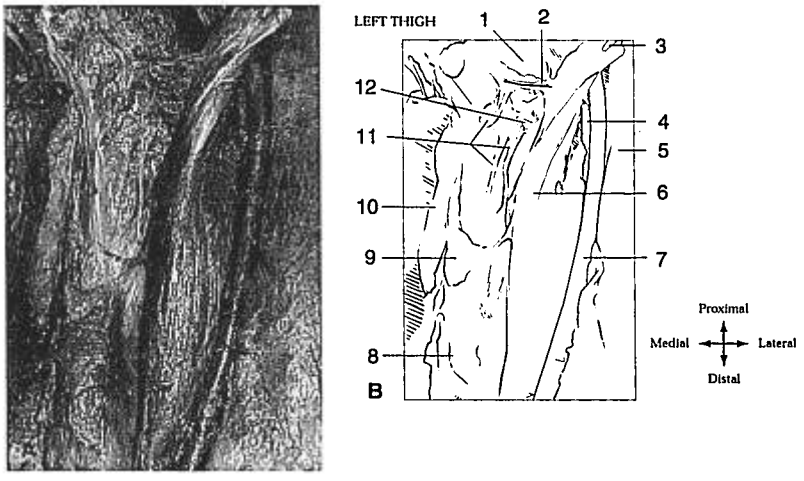

Fig 1A–B. (A) Dissection of left medial thigh. Adductor longus has been retracted laterally to expose the fascial sheet overlying the adductor brevis inferiorly and passing deep to the pectineus proximally. The femoral artery, distended with glycine, lies laterally. The femoral vein and nerve have been removed. Branches of the anterior division of the obturator nerve are visible deep to the fascia distally. (B) Line drawing of dissection in A. 1 = Pectineus muscle left undisturbed; 2 = vessels from the medial circumflex femoral artery to adductor longus; 3 = forceps attached to the pubic origin of adductor longus retracted laterally; 4 = femoral vein; 5 = vastus lateralis; 6 = medial edge of adductor longus facing anteriorly; 7 = femoral artery; 8 = fibrofatty fascial layer overlying adductor magnus; 9 = fibrofatty fascia overlying the gracilis muscle; 10 = fat of medial thigh; 11 = branches from anterior division of the obturator nerve visible beneath fascia; 12 = fibrofatty fascia overlying adductor brevis.

more vascular medial intermuscular septum. In this limb, there were minimal vessels and fascia in the plane overlying the nerve beneath this muscular mass. A similar pattern was found in a preliminary dissection before commencement of this study.

Anterior Division of the Obturator Nerve Course and Variation

The anterior division of the obturator nerve was traced from its emergence into the thigh from the obturator foremen to its final branching in the thigh. The final attachments of the fascia described were not dissected clearly proximal to the level of the obturator foremen. To expose the nerve at the obturator foremen a moderate amount of fat needed to be removed from around it, leaving a large space for the nerve to enter the thigh without contacting bone or fascia (Fig 3). Once they emerged, the nerves encountered in this limited series were diverse in their initial course. Half of the anterior divisions of the obturator nerve entered the thigh as described in Grays' Anatomy[5] by passing over the superior border of obturator externus accompanied by the obturator vein.

In one limb part of the anterior division fibers emerged more distally from the substance of that muscle before rejoining the main bundle. In a second limb the anterior division of the obturator nerve was accompanied by the posterior division of the obturator nerve through the upper portion of that muscle. In four other limbs the anterior and posterior divisions of the obturator nerve emerged into the thigh above the obturator externus. The posterior divisions then passed back through the substance of this muscle (three lateral and the other medial to the anterior division) to reach its deep surface. Once the anterior division of the obturator nerve entered the thigh, it descended deep to the pectineus and the adductor longus be-

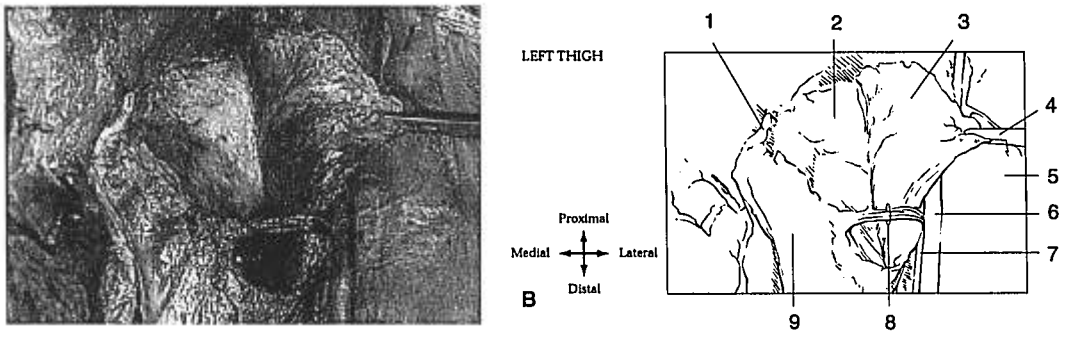

Fig 2A–B. (A) Dissection of left medial thigh. After detachment of the pectineus' pelvic attachment, the fascia can be traced to the pubic bone covering the obturator externus and the emerging anterior division of the obturator nerve. Branches of the medial circumflex femoral artery hook around the pectineus near its lower border heading to the adductor brevis. (B) Line drawing of dissection in A. 1 = Superior pubic ramus; 2 = fatty fascia covering obturator externus and emergence of anterior division of the obturator nerve; 3 = deep surface of the pectineus muscle; 4 = artery forcep clamped to pelvic attachment of the pectineus muscle retracted laterally; 5 = vastus lateralis; 6 = femoral artery; 7 = profunda femoris artery; 8 = branches of the medial circumflex femoral artery arching over medial border of the pectineus muscle branching into the apex of adductor brevis muscle; 9 = adductor brevis muscle.

neath the fascia overlying the adductor brevis, as described. The anterior division of the obturator nerve passed to the apex of the adductor brevis before ramifying into numerous branches. This final branching pattern consisted of three main bundles, with numerous smaller branches appearing in a more random fashion. Most superiorly a branch passed laterally to the superior part of the adductor longus. A second pair of large branches descended more medially to supply the adductor longus and, at a more distal site, the adductor brevis. The most medial of the three groups descended to join with the subsartorial plexus and supply the gracilis (Fig 4).

The anterior division of the obturator nerve was related intimately to the vessels in four sites: First, at the obturator foremen on emergence into the thigh, the anterior division of the obturator nerve was related to the obturator vein, the artery lying at a deeper level in the foramen; second, at the interval between the pectineus and adductor longus, where a branch of the medial circumflex femoral artery ramifies anteriorly to the surrounding muscles; third, the anterior division of the obturator nerve was crossed superficially by vessels (two or three vascular bundles) coursing laterally to medially as the nerve branches descended to the subsartorial plexus; and fourth, just before the branch to the gracilis reaches that muscle it passes deep to a vascular bundle. In addition to these larger vessels, numerous smaller vessels accompany the branches as they descend in the thigh (Figs 3, 4).

In one anatomic specimen, bilateral accessory obturator nerves were encountered, the right being anomalous in its connections with the obturator nerve. This nerve communicated with the posterior and anterior divisions before supplying the pectineus, here being separated from the anterior division by part of the adductor brevis. It then gave the motor branch to the adductor longus, one of two to the adductor brevis (the other coming from the anterior division), and a branch to the subsartorial plexus. It communicated with the anterior division by another two branches (Fig 5).

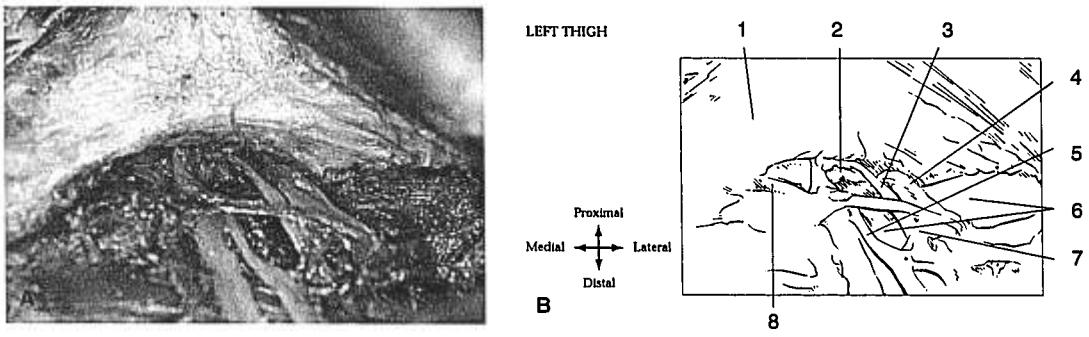

Fig 3A–B. (A) Dissection of left medial thigh. A view of the obturator foramen showing the relationship between the obturator nerve, artery, and vein at this site. The anterior division of the obturator nerve lies to the left (medially) beneath a tributary of the more laterally placed obturator vein. The posterior division of the obturator nerve lies between these before passing through the substance of the obturator externus. The obturator artery lies at a deeper level framed by the two divisions of the obturator nerve. (B) Line drawing of the dissection in A. 1 = Superior pubic ramus; 2 = obturator artery; 3 = posterior division of the obturator nerve; 4 = obturator vein; 5 = motor branch to adductor brevis from the anterior division of the obturator nerve; 6 = obturator externus; 7 = venous tributaries accompanying branches of the medial circumflex femoral artery.

Vascular Arrangement

The more detailed dissection in the appropriately prepared anatomic specimen revealed the medial circumflex femoral artery was responsible for the vessels encountered superiorly in the thigh. Although the main bulk of this vessel passed between the superior border of the pectineus medially and the iliacus laterally destined for anastomoses around

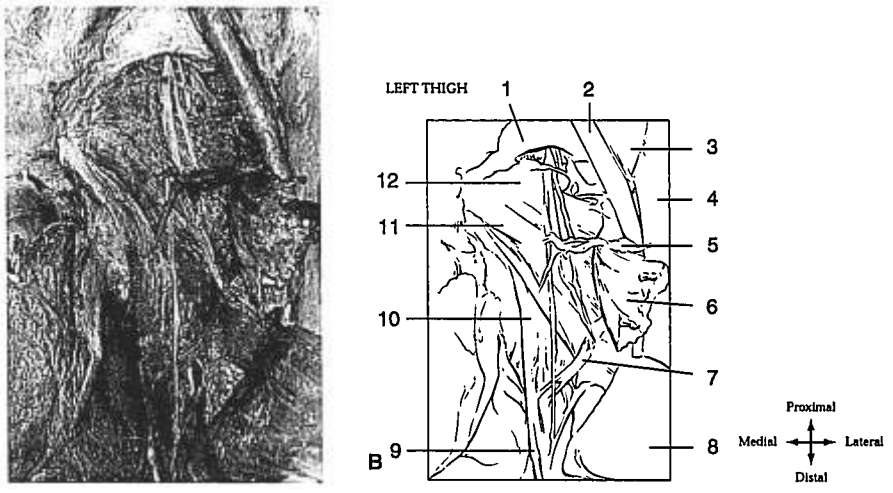

Fig 4A–B. (A) Dissection of left thigh. The fascia overlying the nerve has been removed to show the course of the anterior division of the obturator nerve as it descends on the surface of obturator externus, adductor brevis, and adductor magnus. The close association at three sites between the nerve and vessels in the medial thigh clearly are shown. (B) Line drawing of the dissection in A. 1 = Superior pubic ramus; 2 = femoral artery; 3 = iliopsoas; 4 = vastus lateralis; 5 = branches of the medial circumflex femoral artery; 6 = deep surface of pectineus secured by pins; 7 = branches of profunda femoris artery; 8 = deep surface of adductor longus; 9 = gracilis; 10 = adductor magnus; 11 = adductor brevis; 12 = obturator externus.

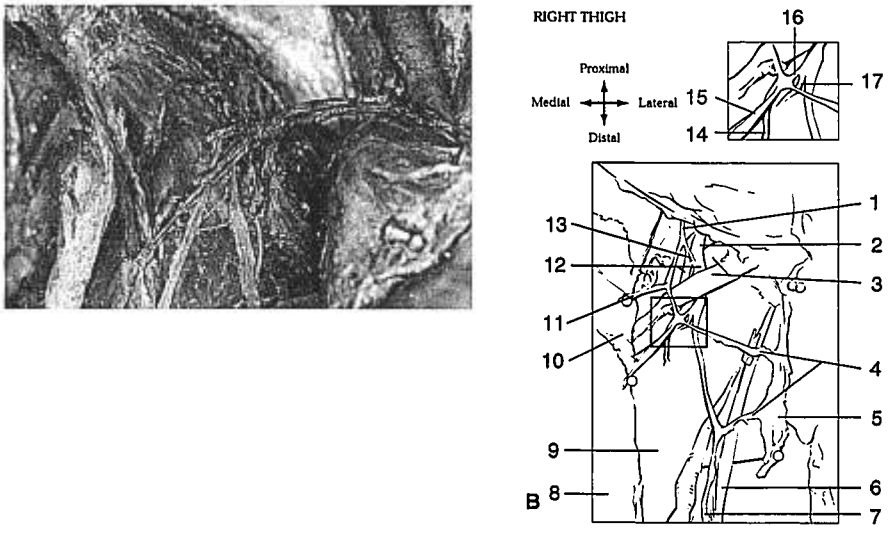

Fig 5A–B. (A) Dissection of right thigh. In one limb an accessory obturator nerve was found with numerous connections to both divisions of the obturator nerve and with the final branches of the anterior division of the obturator nerve. (B) Line drawing of the dissection in A. One area has been enlarged to clarify the branching pattern of the anterior division of the obturator nerve and the accessory obturator nerve. 1 = Accessory obturator nerve; 2 = obturator nerve; 3 = obturator externus; 4 = branches to skin of medial thigh from the accessory nerve proximally and the anterior division of the obturator nerve distally; 5 = fascia of medial thigh; 6 = gracilis; 7 = motor branch to gracilis; 8 = adductor longus reflected laterally; 9 = adductor brevis; 10 = pectineus muscle reflected laterally; 11 = motor branch to pectineus; 12 = posterior and anterior divisions of the obturator nerve; 13 = connection between the accessory obturator nerve, anterior division of the obturator nerve, and the posterior division of the obturator nerve; 14 = motor branch to adductor brevis; 15 = motor branch to adductor longus; 16 = connection between accessory obturator nerve and motor branch to adductor brevis; 17 = motor branch to adductor brevis from anterior division of the obturator nerve.

the hip joint, it gave one large branch over the superficial surface of the pectineus, which ramified to supply the adductor longus, brevis, and pectineus superficial to the anterior division of the obturator nerve. The branches encountered more distally were from the profunda femoris artery and its perforating branches, which in turn descended obliquely across the nerve. More distally the nerve was related to branches of the profunda femoris artery destined for the gracilis and adductor magnus given off just before the profunda femoris artery passed deep to the adductor longus.

The veins accompanying the arteries freely communicated with the larger obturator vein, medial circumflex femoral vein, and the profunda femoris vein. Each arterial branch passing over the nerve tended to be accompanied by two venae comitantes making this a vascular fascial plane superficial to the anterior division of the obturator nerve and its branches.

DISCUSSION

The concept that entrapment of the obturator nerve can cause adductor region pain only recently has been proposed and published.[2] The authors of this article[2] thought that fascia over the nerve contributed to compression of the nerve or perhaps allowed for the development of a compartment syndrome. This appears to be verified by the promising early results with simple division of the fascia and vessels overlying the nerve.[2] To help with the surgical exposure and to try to delineate a cause for the nerve entrapment, a

more precise description of the regional anatomy of the anterior division of the obturator nerve was undertaken. The standard description of the obturator nerve can be obtained from Gray's Anatomy.[5] The obturator nerve arises from the ventral rami of the second, third, and fourth lumbar nerve roots that unite in the posterior part of the psoas major. It emerges from the medial border of the muscle and descends outward and downward over the ala of the sacrum, pelvic brim, to the lesser pelvis. It passes through the obturator canal and divides within into two divisions. The anterior division of the obturator nerve gives an articular branch to the hip joint near its origin. It descends anterior to the obturator externus and adductor brevis deep to the pectineus and adductor longus. It supplies muscular branches to the adductors longus, brevis and the gracilis, and rarely to the pectineus. It divides into numerous named and unnamed branches, including the cutaneous branches to the subsartorial plexus and directly to the skin of the medial thigh, vascular branches to the femoral artery, and communicating branches to the femoral cutaneous and accessory obturator nerves. The posterior division of the obturator nerve pierces the anterior part of the obturator externus, which it supplies, and descends deep to the adductor brevis. It supplies the adductors magnus and brevis (if it has not received supply from the anterior division) and gives an articular branch to the knee joint.

The description outlined in Gray's Anatomy represented that found in the anatomic specimens, except for the more variable relationship encountered between the anterior division of the obturator nerve, posterior division of the obturator nerve, and obturator externus. Although the existence of an accessory obturator nerve that supplies the pectineus, the hip joint, and communicates with the anterior division of the obturator nerve is relatively common (69 of 800 cadavers in Gray's Anatomy[5] and 8% per Sunderland[9] in his detailed study of the peripheral nervous system), it has not been observed to supply the adductors as extensively as that encountered in one limb of this series. Care needs to be taken when dissecting the fascia superiorly where the obturator nerve emerges from the foramen to avoid damage to this nerve, if present, because it descends over the ramus to join the anterior division below.

Detailed descriptions of the fascia lata and medial intermuscular septum can be found in Gray's[4] and Last's[6] anatomy texts. Most work on the fascia of the thigh has concentrated on the fascia lata and its attachments to the inguinal ligament and the distal femur. The more detailed texts comment on numerous smaller intermuscular septa passing between the muscles ensheathing them and giving partial attachment to them.[4,10] Gerlach and Lierse[3] performed a detailed study of the fiber orientation within the fascial construct in the lower limb. They have described two distinct septa in the medial compartment of the thigh passing from the fascia lata to the femur, one ventromedial, and the other dorsomedial separating the whole adductor mass from the other muscular compartments of the thigh, but they make no comment on the fascial development within the adductor compartment. Thorough research of the Western literature revealed no published series of dissections concentrating on this area of fascia.

The fascial development, especially with the perivascular condensations around the vessels supplying the adductor mass, constituted a layer definite enough to create an entrapment of the anterior division of the obturator nerve. This thickening around the vessels becomes more significant in the possible explanation of an entrapment syndrome when the intimate relationship between the nerve branches and the vessels is considered. The vascular pedicle derived from the medial circumflex femoral artery to the pectineus, adductor longus, and adductor brevis surround the nerve as it runs up toward the apex of the triangular shaped brevis muscle, creat-

ing an increase in the overlying fascia at this point (Fig 6). It may be this is the more important anatomic arrangement in the etiology of the entrapment syndrome, rather than the development of the layer as a whole. This is consistent with the arrangement found at operation for this condition.[2]

In 1991 Peri[8] performed a series of dissections to delineate anatomic sites of possible entrapment for peripheral nerves. He described three critical zones for the obturator nerve, including the intermuscular interval between the pectineus and obturator externus muscles and between the adductor longus and adductor brevis for the anterior division of the obturator nerve. The work does not provide a clear anatomic description of the sites observed, but it is the only reference to anterior division of the obturator nerve compression available in the current literature. The obturator foramina dissected in the current study allowed space for the nerve to emerge. The presence of moderate amounts of compressible fat that separated the nerve from surrounding structures may help prevent impingement in the absence of other pathologic features at this site.

In the current study the vessels that would be encountered when approaching and decompressing the anterior division of the obturator nerve mainly were derived from the medial circumflex femoral and profunda femoris arteries. The arterial supply to the adductors is related intimately to the obturator nerve, and the branches of these vessels would need to be divided for exposure and decompression. (The surgical approach to the nerve used by the senior author is via the interval between the pectineus and adductor longus.) The nerve then is delineated lying on the adductor brevis beneath the fascia described. The muscles have more than one vascular pedicle, and there should be no sequelae to the division of the vessels at the interval between the pectineus and adductor longus that is required if the nerve is to be approached here.

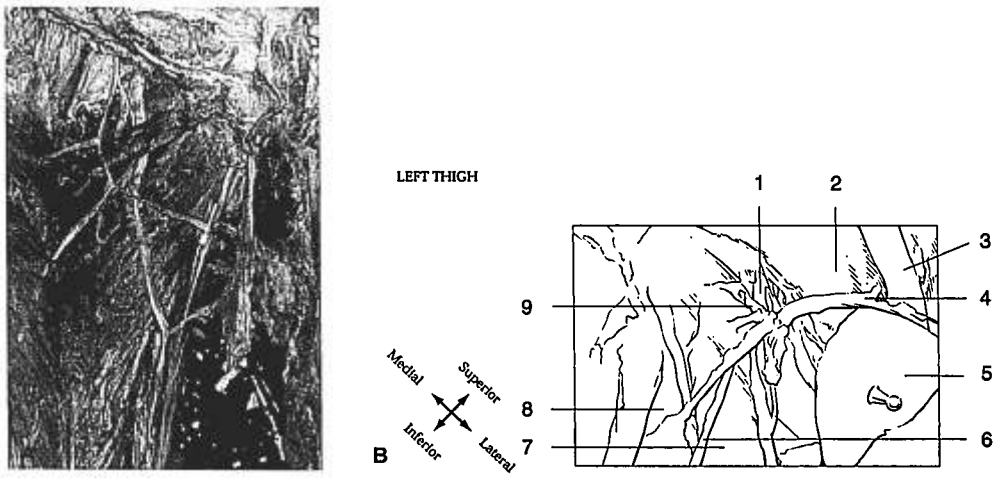

Fig 6A–B. (A) Dissection of left thigh. A muscular branch of the medial circumflex femoral artery, here displaced by the retraction of the pectineus, showing the intimate relationship between its branches to the adductor muscles in this region and the branches of the anterior division of the obturator nerve. (B) Line drawing of the dissection shown in A. 1 = Anterior and posterior divisions of the obturator nerve; 2 = superior pubic ramus; 3 = femoral artery; 4 = muscular branch of medial circumflex femoral artery to superficial adductor musculature; 5 = pectineus retracted laterally; 6 = terminal branches of the anterior division of the obturator nerve; 7 = adductor brevis; 8 = gracilis; 9 = branches of the anterior division of the obturator nerve beneath branches of medial circumflex femoral artery on the surface of adductor brevis.

With approach to the nerve in this fashion, there are three potential areas of bleeding. The first is at the interval between the pectineus and adductor longus, where the branches to these muscles and the adductor brevis from the medial circumflex femoral artery arise as the latter descends toward the apex of the adductor brevis. It is here that the anterior division of the obturator nerve is closely related as the vessels divide into their final muscular branches. The superficial and almost transverse course of the medial circumflex femoral artery across the surface of the pectineus allows safe approach to the artery clear of the nerve, which lies deep to the muscle here. The second site of bleeding occurs when the fascia is divided distally. Here the pattern of vessels was more variable, but the branches tended to arise directly from the profunda femoris artery or one of its perforating branches. The vessels lie lateral to the nerve until well distal in the thigh before approaching the motor branch to the gracilis and branches to the subsartorial plexus. The third site of bleeding is the obturator foramen. Here the venous connections are numerous between the veins accompanying the branches of the medial circumflex femoral artery and the obturator veins. Venous tributaries were found deep and superficial to the nerve as it appeared at the obturator foramen. The obturator artery lies at a deeper plane within the obturator canal and appears safe from damage with gentle blunt dissection.

References

1. Ashby EC: Chronic obscure groin pain is commonly caused by enthesopathy: `Tennis elbow' of the groin. Br J Surg 81:1632–1634, 1994.
2. Bradshaw C, McCrory P, Bell S, Bruckner P: Obturator neuropathy a cause of chronic groin pain in athletes. Am J Sports Med 25:402–408, 1997.
3. Gerlach UJ, Lierse W: Functional construction of the superficial and deep fascia of the lower limb in man. Acta Anat 139:11–25, 1990.
4. Gray H: Myology. In Williams P, Warwick R (eds). Gray's Anatomy. Ed 36. London, Churchill Livingstone 595–596, 1990.
5. Gray H: Neurology. In Williams P, Warwick R (eds). Gray's Anatomy. Ed 36. London, Churchill Livingstone 1108, 1990.
6. Last RJ: Lower Limb. In McMinn RMH (ed). Last's Anatomy, Regional and Applied. Ed 8. London, Churchill Livingstone 149–152, 1990.
7. Martens MA, Hansen L, Mulier JC: Adductor tendinitis and musculus rectus abdominis tendonopathy. Am J Sports Med 15:353–356, 1987.
8. Peri G: The `critical zones' of entrapment of the nerves of the lower limb. Surg Radiol Anat 13:139–143, 1991.
9. Sunderland S: Obturator Nerve. In Sunderland S (ed). Nerves and Nerve Injuries. Ed 2. London, Churchill Livingstone 992–998, 1990.
10. Thane GD: Muscles and Fasciae of the Lower Limb. In Schafer EA, Thane GD (eds). Quain's Elements of Anatomy. Vol 2. Part 2. London, Longmans Green and Company 241–273, 1899.
11. Zimmerman G: Groin pain in athletes. Aust Fam Physician 17:1046–1052, 1988.