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ORIGINAL ARTICLE

Anatomy and potential clinical significance of the vastoadductor membrane

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Abstract Few reports are found in the extant medical literature regarding the vastoadductor membrane. This membrane effectively creates a subcompartment within the subsartorial canal. The lower limbs of 16 embalmed adult cadavers were dissected to identify the vastoadductor membrane and note its measurements. A vastoadductor membrane was identified in all specimens and was derived from the medial intermuscular septum. This membrane connected the medial edge of the vastus medialis muscle to the lateral edge of the adductor magnus muscle. Membranes were all wider proximally and narrowed distally. The mean length of this structure was 7.6 cm. The mean width of the vastoadductor membrane at its proximal, midportion, and distal parts was 2.2, 1.7, and 0.5 cm, respectively. The mean distance from the anterior superior iliac spine to the proximal border of the vastoadductor membrane was 28 cm. The mean distance from the distal border of the membrane to the adductor tubercle was 10 cm. Seventy-five percent of specimens exhibited a fenestrated vastoadductor membrane. Branches of the saphenous nerve to the skin of the medial thigh pierced the vastoadductor membrane in 31% of specimens. Two specimens demonstrated branches derived from the branch of the obturator nerve that pierced this membrane en route to the skin of the medial thigh. Perforating venous branches from the great saphenous vein were identified in 22% of specimens. As compression of the femoral artery at the adductor hiatus is a well-recognized entity, the clinician may also try to explore potential compression of this vessel more proximally by an overlying vastoadductor membrane. The authors would also hypothesize that due to the interconnection between the adductor magnus and vastus medialis by the vastoadductor membrane that a potential synergy exists between the functions of these two muscles.

Keywords Anatomy · Thigh · femoral nerve · Quadriceps · Lower extremity · Vastoadductor membrane

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Introduction

The vastoadductor membrane is rarely reported in the literature and to our knowledge, none of these has performed detailed structures of its morphology and relationships. In regard to this structure, Woodburne [14] has stated that in the lower one-third of the thigh, tendinous fibers spread laterally from the rounded tendon of the adductor magnus toward the vastus medialis and end in the medial intermuscular septum.

This author continued by describing this connective tissue as one overlying the femoral vessels in the distal segment of the adductor canal and that it may be pierced by the saphenous nerve and the descending genicular artery. Romanes [8] stated that "(the medial intermuscular septum) becomes more indistinct, but there is a well-marked thickening of a layer of fascia deep to the sartorius muscle. This layer binds the vastus medialis to the adductor longus and adductor magnus, and forms a roof for the adductor canal". Callander [1] stated that the roof of the adductor canal is a layer of deep fascia running from the adductor longus and magnus muscles to the vastus medialis muscle. This author denoted this as the fascia vasto-adductoria. Interestingly, some have included the vasto-adductor "lamina" as an attachment site for the vastus medialis muscle [13]. With few descriptions and no detailed studies of the vastoadductor membrane, the present anatomical study was done in order to elucidate further this structure.

Materials and methods

Sixteen formalin-phenol-alcohol fixed adult cadavers (32 sides) aged 48–90 years (mean 80 years) underwent a detailed dissection of the area of the subsartorial canal. There were nine male and seven female cadavers. No pathology or overlying surgical scars were identified in any specimen in the areas of dissection. The sartorius muscle was identified and reflected laterally. In the next step, the connective tissue overlying the vastus medialis and adductor magnus muscles was dissected. The vastoadductor membrane was identified and measurements were made of its length and width. The width was made at its proximal, midportion, and distal parts. Additionally, the relationships to regional nerves and vessels were documented and the distances between this structure and the anterior superior iliac spine (ASIS) and adductor tubercle were measured with rulers. Statistical analyses were made using SPSS 8.0 software for Windows with significance set at $P < 0.05$.

Results

A vastoadductor membrane was identified in all specimens (Figs. 1, 2, 3, 4, 5, 6) and was derived from the medial intermuscular septum. This membrane traversed from the medial edge of the vastus medialis muscle to the lateral edge of the

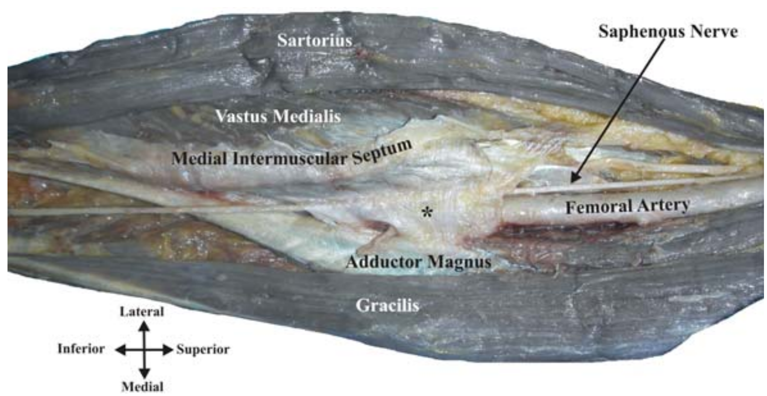

Fig. 1 Right lower limb illustrating the vastoadductor membrane (*asterisk*). Note the perforating branch of the saphenous nerve exiting the vastoadductor membrane

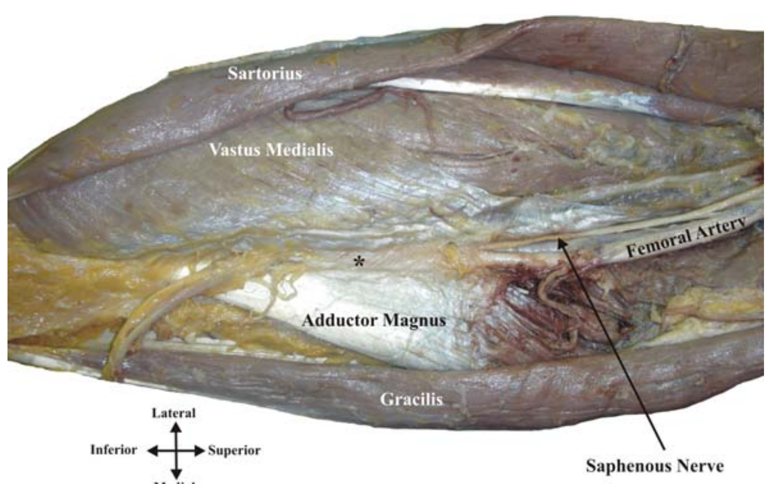

Fig. 2 Right lower limb illustrating the vastoadductor membrane (*asterisk*). Note the saphenous nerve proximal and distal to the membrane

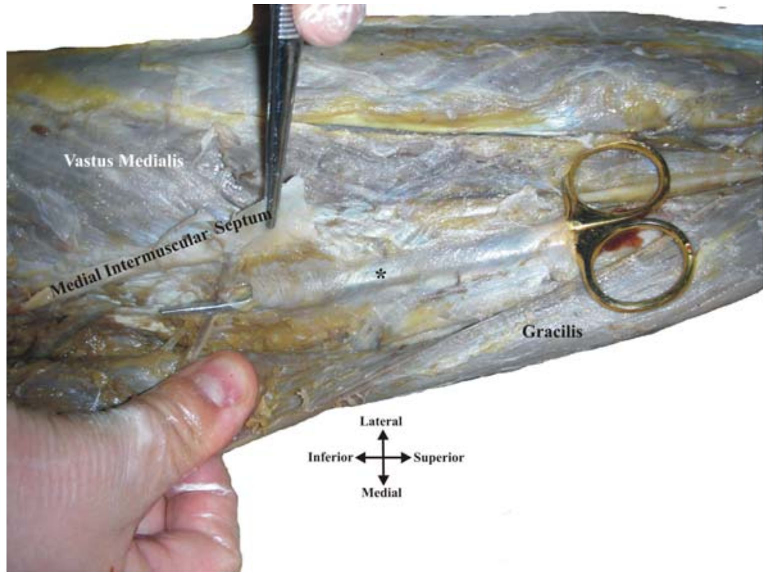

Fig. 3 Right long vastoadductor membrane (*asterisk*) with scissors placed deep into the membrane. The forceps are pulling up on the cut edge of the medial intermuscular septum

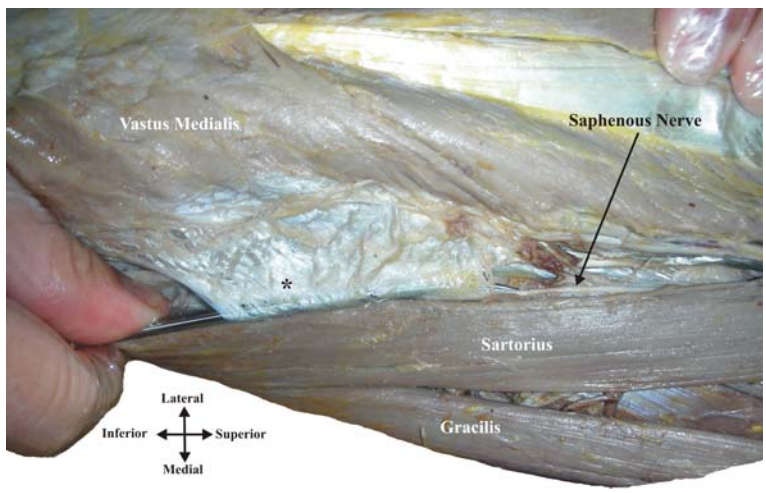

Fig. 4 Wide vastoadductor membrane (*asterisk*). The probe is deep into this structure

adductor magnus muscle and its distal tendon in approximately the coronal plane. In the majority of specimens, this membrane was rhomboid in shape and wider proximally and more narrow distally. The fiber course of the majority of membranes was oblique from a superior to medial direction. Some membranes were also noted to have a proximal fiber course that was horizontal in nature and distal fibers that were oblique, again from a superomedial direction. The length of this structure ranged from 5.5 to 15 cm (mean 7.6 cm). The width of the vastoadductor membrane at its proximal, midportion, and distal parts had means of 2.2, 1.7, and 0.5 cm, respectively. The ranges of these segments were 1.8–3, 1–2, and 0.1–1 cm, respectively. The distance from the ASIS to the proximal border of the vastoadductor membrane was found to have a mean of 28 cm (range 20–32 cm). The distance from the distal border of the membrane to the adductor tubercle ranged from 7 to 15 cm (mean 10 cm). Of the 32 sides, 24 sides (75%) exhibited a fenestrated vastoadductor membrane (Figs. 5, 6). Branches of the saphenous nerve to the skin of the medial thigh pierced the vastoadductor membrane on ten sides (31%). No specimen exhibited a main saphenous nerve trunk that pierced this membrane. Two specimens (two right sides) demonstrated branches derived from the branch of the obturator nerve (derived from its anterior division) that pierced this membrane en route to the skin of the medial thigh. The descending genicular artery or its saphenous branch did not pierce the vastoadductor membrane in any specimen. Perforating venous branches from the great saphenous vein were identified on seven sides (22%). No obvious compression was noted of the femoral artery or vein as they traveled deep to the vastoadductor membrane. Although the vastoadductor membrane tended to be greater in length in male versus female specimens, no statistical significance ($P < 0.05$) was found regarding this or the other measurements made. In addition, there was no statistically significant difference in measurements with regards to age, gender and side, where the specimens derived from.

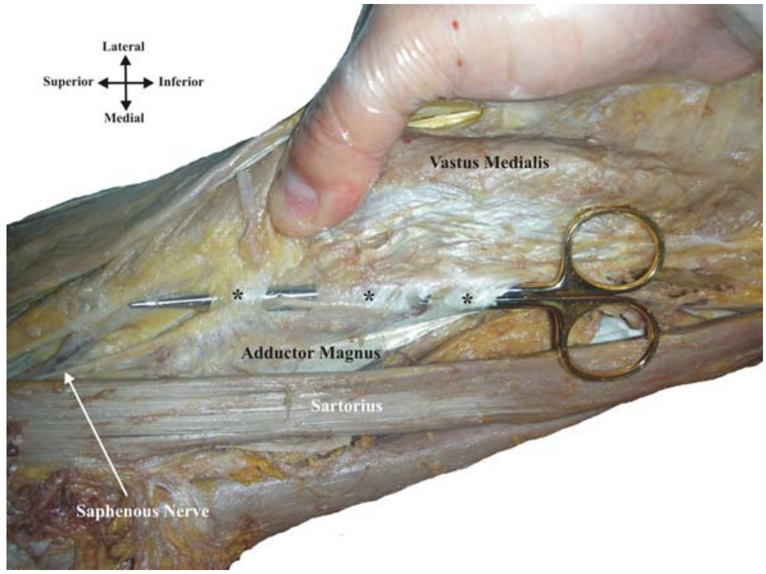

Fig. 5 Fenestrated vastoadductor membrane (*asterisk*)

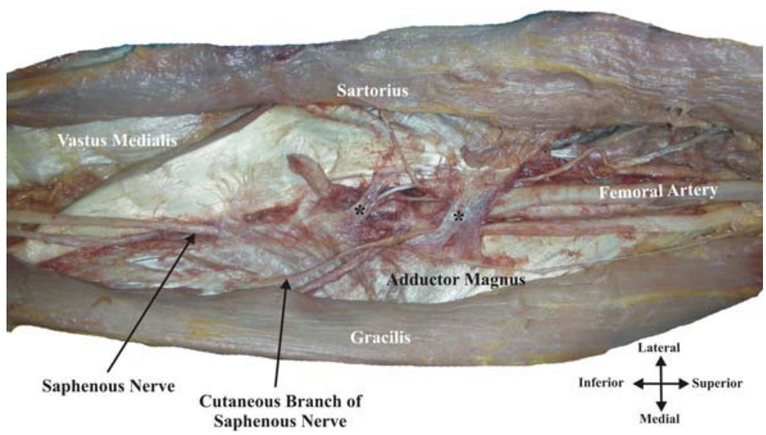

Fig. 6 Another specimen demonstrating a fenestrated vastoadductor membrane (*asterisk*)

Discussion

In describing the medial intermuscular septum of the thigh, Hollinshead [3] described a continuation of this structure as "especially thickened" and as forming the roof of the adductor canal. This roof is in effect, the vastoadductor membrane. Checroun et al. [2] stated in their paper regarding surgical exposures of the femur that the distal end of the vastoadductor membrane is on average, 9 cm from the adductor tubercle and is a strong thickened fascial band that connects the vastus medialis with the adductor magnus and its tendon. These authors went further by naming this membranous area the "danger zone" and reported of it having a mean length of 6 cm. Our measurements are comparable to those of these authors with a mean distance from the proximal edge of the membrane to the adductor tubercle measuring 10 cm and a mean length of the membrane of 7.6 cm. Checroun et al. [2] also stated that the saphenous artery and nerve constantly "exit out of the vastoadductor membrane". If these authors meant that these two structures passed out toward the knee deep into the membrane, then this coincides with our findings. However, if the meaning was that these structures pierce the membrane, then our findings contradict their finding. When the membrane was perforated by neurovascular structures, we found this to be by only cutaneous branches of the saphenous and obturator nerves to the skin of the medial thigh, communicating branches between the great saphenous vein and the deep venous system, and muscular and cutaneous branches from the femoral artery.

Surgically, the proximal aspect of the vastoadductor membrane, and its canicular appearance, can be mistaken for the adductor hiatus [2] Scheibel et al. [10], in describing the subvastus region for application to total knee arthroplasty, included the vastoadductor membrane as its medial boundary. These authors also, as did Checroun et al., described the main trunk of the saphenous nerve and artery as passing through this membrane, which again was not found in our study [2].

Clinically, Luerssen et al. reported six patients presenting with spontaneous nontraumatic saphenous neuralgia secondary to entrapment of the saphenous nerve in the subsartorial canal [5]. These patients presented with medial knee and leg pain with tenderness over the subsartorial canal and sensory deficits in this nerve's distribution. Nerve blocks of the saphenous nerve confirmed the diagnosis. All patients underwent operative intervention for their saphenous nerve entrapment with symptomatic improvement in each of them. As we identified specimens in whom the branch of the saphenous nerve to the skin of the medial thigh pierced the vastoadductor membrane, the clinician might wish to consider this as a site of possible entrapment. Scheibel et al. stated that when a subvastus technique for knee arthroplasty is used, the saphenous nerve should be considered [10]. Morganti et al. stated that unrecognized saphenous neuritis could confuse a patient's clinical presentation and complicate treatment [6]. Saphenous nerve injury or entrapment results in pain along the distribution of this nerve and particularly at the knee [9, 15]. Lewis [4] has hypothesized that restless leg syndrome may be due to entrapment of the saphenous nerve along its course such as in the subsartorial canal (Hunter's canal). To support this notion, Mozes et al. reported 32 patients in whom saphenous nerve entrapment was found to result in a painful syndrome simulating a vascular disorder of the leg [7]. As found in roughly one third of sides in our study and stated earlier, perforating branches of the saphenous nerve to the skin of the medial thigh could conceivable become entrapped in the vastoadductor membrane.

Tung et al. [11] identified 61% of their patients as having one or more communicating veins with the great saphenous vein within the adductor canal. These authors concluded that such communications should be investigated with phelebography in patients with recurrent varicose veins. We identified such communicating veins that also pierced the vastoadductor membrane in 22% of studied sides.

The vastoadductor membrane effectively creates a subcompartment within the subsartorial canal. This structure, which was adjacent and superior to the distal tendon of the adductor magnus muscle, may be the same band described by Verta et al. [12]. These authors described this band as leading to acute occlusion of the femoral artery in young men following exercise. The treatment for such a constriction was the simple division of the abnormal band with restoration of arterial blood flow to the leg. Although Verta et al. [12] described the vastoadductor membrane as an abnormal band, we identified this structure in all of our specimens. As compression of the femoral artery at the adductor hiatus is a well-recognized entity, the clinician may also try to explore potential compression of this vessel more proximally by an overlying vastoadductor membrane.

Conclusions

The detailed anatomy of the vastoadductor membrane, to our knowledge, has not been previously reported. We opine that the results of our study would definitely add much to the existing anatomical knowledge and clinical implications of the vastoadductor membrane.

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