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The neurovascular anatomy of the teres major muscle

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Background: Information in recent literature on the teres major muscle (TM) is limited and, at times, contradictory. Exact information on its neurovascular supply is clinically relevant for its use in a free or pedicled muscle transfer in reconstructive shoulder surgery. Therefore, the aim of this study was to analyze the TM topographically, especially its neurovascular supply and its macroscopic appearance.
Materials and methods: Thirty upper extremities of 15 human cadavers (7 female and 8 male cadavers) were investigated during the students' dissection course of our anatomic department in the winter term of 2012.
Results: The lower subscapular nerve (LSN) innervated the TM in 86.6% of shoulders. In 13.3%, the thoracodorsal nerve (TDN) supplied the muscle. The LSN's branch was 49.8 ± 11.8 mm long. The TDN's branch was 83.5 ± 9.8 mm long. The entry of the neurovascular pedicle was located almost in the center part of the muscle. The arterial branch was 33.6 ± 7.3 mm long.
Discussion: In general, the LSN innervates the TM. However, in 10% to 20% of shoulders, the TDN innervates this muscle. The branch of the TDN supplying the TM is longer than the branch of the LSN. In a muscle transfer, the vessels are the predictable limiting factor for translation because they are shorter than the nerve. The artery, nerve, and vein enter the muscle in a close relationship (<2 cm). It is useful to describe the entry point as an area of 2 cm in diameter around the middle of the TM.
Level of evidence: Basic Science, Anatomy, Cadaveric Dissection.

Keywords: Teres major muscle; neurovascular supply; upper extremity; musculoskeletal system; lower subscapular nerve; thoracodorsal nerve; circumflex scapular vein; thoracodorsal vein

The teres major muscle (TM) has been used in clinical practice for transfer or transposition since 1934. It was first used in children with obstetric brachial plexus palsy.[12] Nowadays, the TM is used singly or combined with the latissimus dorsi muscle (LDM) for the reconstruction of irreparable posterosuperior rotator cuff tears[19] or as a single substitute for an irreparably torn infraspinatus muscle.[5]

The TM is supplied by a dominant neurovascular pedicle through its anterior surface.[27] Various authors of anatomic textbooks (Table I) describe the thoracodorsal nerve (TDN)[2,11,13,20,26] or the lower subscapular nerve (LSN)[9,16,23,24,28] as the neural supply to the TM, whereas others

This article is based on the diploma thesis of the first author.
The cadavers were donated by persons who had given their informed consent for their use for scientific purposes before death.

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Table I Comparison of various anatomic textbooks concerning TM

Authors	TM innervation		Nerves	
	Innervation	Segments	LSN innervates	TDN innervates
Aumüller et al[2]	TDN (p. 404)	C6-C8 (p. 404)	SSM (p. 419)	LDM (p. 419)
Benninghoff and Drenckhahn[3]	TDN, LSN (p. 298)	C6-C7 (p. 298)	SSM, TM (p. 298)	LDM (p. 292)
Fanghänel et al[7]	TDN and/or SSN (p. 696)	C6-C7/C5-C6 (p. 696)	SSM, TM (p. 730ff)	LDM (p. 730ff)
Hafferl and Thiel[9]	LSN (p. 707)	—	SSM, TM (p. 709)	LDM (p. 709)
Kahle and Frotscher[10]	—	—	SSM, TM C5-C7 (p. 74)	LDM (p. 74)
Leonhardt et al[11]	—	—	SSM (pp. 380, 429), TM C5-C6 (C7) (p. 428)	LDM, (TM) (pp. 380, 430)
Lippert[13]	TDN (p. 661f)	—	SSM (pp. 661, 667)	LDM, TM (pp. 661, 667)
Martini et al[14]	TDN, LSN (p. 320)	C5-C6 (p. 320)	SSM, TM (p. 409)	LDM (p. 409)
Netter[16]	LSN (pp. 397, 400, 446)	—	—	—
Paulsen and Waschke[17]	—	—	SSM, (TM) C5-C7 (p. 36)	LDM, TM (p. 36)
Paulsen and Waschke[18]	—	—	SSM, C5-C7 (p. 199)	LDM, TM C6-C8 (p. 199)
Platzer[20]	TDN (p. 140)	C6-C7 (p. 140)	—	—
Schünke et al[23]	LSN (pp. 300, 318)	C5-C8 (pp. 300, 318)	SSM, TM (p. 291)	LDM (p. 291)
Sieglbauer[24]	LSN (p. 240)	C6-C7 (p. 240)	SSM (p. 652f)	LDM, TM (p. 652f)
Tillmann and Töndury[25]	TDN (p. 371)	C6-C7 (p. 371)	SSM (p. 370)	LDM, TM (p. 371)
von Lanz et al[26]	TDN (p. 56)	C6-C7 (p. 56)	SSM (p. 68)	LDM, TM (p. 72)
Williams et al[28]	LSN (p. 614)	C6-C7 (p. 614)	Lower part of SSM, TM (p. 1132)	LDM (p. 1132)

SSM, Subscapular muscle; *SSN*, subscapular nerve.

mention both nerves.[3,7,14] Earlier studies (Table II) described a dominant innervation only by the LSN.[1,4,8,19,27]

The arterial supply of the TM is provided by branches of the subscapular artery,[7] either the thoracodorsal artery (TDA)[8] or the circumflex scapular artery (CSA)[1,4,8,19,27]; a direct branch of the subscapular artery[27] is also mentioned. Wang et al[27] described various cases of secondary arterial branches arising from the CSA. According to existing data, the length of the artery is shorter than that of the nerve (Table III).

The venous blood drains through the circumflex scapular vein (CSV).[1,8,27] In all cases, there is a dominant major vein. Additional veins have been described in numerous specimens (Table IV).[1,8]

The muscular origin is from the lower third of the lateral margin of the scapula, near its inferior angle.[7,20,24] From origin to insertion, the TM becomes narrower and flatter. Its length and the dimension of its tendinous part vary frequently (Table V).[1,4,8,19,27]

The TM has been clinically used for more than 75 years, but information on its topography and neurovascular supply remains somewhat contradictory and limited. The aim of this study was to identify and analyze the neurovascular anatomy through a series of cadaveric dissections and compare this with what is known in the literature.

Materials and methods

The study was performed using 30 forequarter specimens of 15 human cadavers. The cadavers were donated by persons who had given their informed consent for their use for scientific purposes.[15,22] All cadavers were preserved using a formaldehyde-phenol solution.[21] The investigation took place during a topographic dissection course in the winter term of 2012.[6]

The dissections were performed by a specially trained group of 5 anatomy demonstrators of the department under supervision of the principal investigator. Each cadaver was dissected in the supine position. The skin, subcutaneous tissue, pectoralis major and minor muscles, and fatty tissue of the axillary groove were removed. The origin of the subscapular artery branch of the axillary artery was dissected. Subsequently, the TDA and the CSA were identified. The CSV and thoracodorsal vein (TDV) were adjacent to the arteries. The TDN and the LSN were identified at their origin from the posterior cord. The courses of all these structures were dissected to display branches to the TM and to investigate their entry into the muscle.

Macroscopic measurements were performed with the arm in a neutral position (0° of abduction, 0° of flexion). All measurements were performed by the principal author using a digital slide caliper (Lidl, Neckarsulm, Germany). After the dissections had been completed, the data were entered into a Microsoft Excel 2007 spreadsheet (Microsoft, Redmond, WA, USA).

Neurovascular supply

First, the artery leading to the TM was identified, its exact origin from the arterial system (CSA or TDA) was specified, and the outer diameter was noted. The numbers of arterial branches entering the muscle were counted. The outer diameter of these portals was measured in the resting state. We defined the entering branch with the largest diameter as the main branch (Fig. 1).

The distance between the vessel's muscular entry and its separation from the TDA or CSA was specified as the ''length of the