Case Report
Acta Medica Academica 2022;51(3):212-216
DOI: 10.5644/ama2006-124.391

A Hypertrophic Anterior Scalene Muscle and the Passage of a Subclavian Artery Through its Fibres: The Location of Possible Entrapment

George Tsakotos[1], Vasilios Karampelias[1], Ilenia Chatziandreou[2], Dimitrios Philippou[1], Trifon Totlis[3], Maria Piagkou[1]

[1]Department of Anatomy, Medical School, Faculty of Health Sciences, National and Kapodistrian University of Athens, [2]1st Department of Internal Pathology, Medical School, Faculty of Health Sciences, National and Kapodistrian University of Athens, [3]Department of Anatomy and Surgical Anatomy, Faculty of Health Sciences, Aristotle University of Thessaloniki

Correspondence: *gtsakotos@gmail.com*; Tel.: + 30 69 77601081

Received: 21 June 2022; **Accepted:** 15 August 2022

Abstract

Objective. The presence of cervical ribs, 1st rib anomalies, cervical muscle hypertrophy and repetitive motion are possible aetiologies of subclavian artery (SCA) entrapment and/or compression. Thoracic outlet syndrome of the arterial type may appear with symptoms of hand pain due to the aneurismal part of the compressed SCA. The current cadaveric case describes a hypertrophic right-sided anterior scalene muscle (ASM) and the possible entrapment of the right SCA (RSCA) passing through its fibres. Furthermore, the branching pattern of the entrapped vessel is analysed. **Case Report.** A hypertrophic ASM was identified in the right infraclavicular area of a male Greek donated cadaver (70 years of age). The RSCA passed through the ASM belly, and some deeply situated fibres extended posteriorly to the RSCA. The ASM compressed the RSCA against the superior part of the 1st rib. **Conclusion.** Knowledge of such variants may be important in the diagnosis of upper limb muscle atrophy or neurosensory loss.

Key Words: Thoracic Outlet Syndrome ▪ Anterior Scalene Muscle ▪ Variant ▪ Compression ▪ Subclavian Artery.

Introduction

The presence of some anatomical variants, such as cervical ribs, 1st rib anomalies, hypertrophy of the cervical muscles in combination with repetitive motion, as well as fibrocartilaginous bands (1-3) may cause subclavian artery (SCA) entrapment and/or compression (2, 4-8). In addition, the atypical passage of the SCA through the anterior scalene muscle (ASM) or posterior to it (9, 10) may cause compression on the SCA.

Thoracic outlet syndrome (TOS), an extensively studied entity, includes a constellation of disorders that arise from the compression of the brachial plexus, and/or the subclavian and axillary vessels within the thoracic outlet, due to the narrow apertures and compartments created by the first rib inferiorly, the surrounding musculature and the clavicle, as well as the anterior and middle scalene muscles (11, 12). TOS sites of compression are the interscalene triangle, followed by the costoclavicular triangle or the subcoracoid and pectoralis minor space (1, 13). The arterial form of the syndrome includes hand pain due to the aneurismal part of the compressed SCA. It is also characterized by chronic and repetitive SCA compression, which may lead to arterial wall damage, aneurysm, embolization, and thrombosis (5, 7, 8, 14).

The current cadaveric case describes an unusual case of hypertrophic right sided ASM and the possible entrapment of the right SCA (RSCA) due to its course through the ASM fibres. Furthermore, it analyses the branching pattern of the entrapped vessel.

Case Presentation

During a routine dissection at the Anatomy Department of the Medical School of the National and Kapodistrian University of Athens, the unusual course of the RSCA through the ASM fibres was identified in a 70-year-old male cadaver, derived from a body donation programme after signed informed consent. The cause of death was cardiac arrest, with no other identified pathologies. No further details of the clinical file of the subject existed. The cadaver presented a right hypertrophic ASM and the RSCA passed through the ASM belly and some deeply situated fibres extended posteriorly to the RSCA, the so-called ASM posterior fibres (PF) (Figures 1, 2).

The RSCA branching pattern sequence was as follow: right vertebral artery (RVA), right thyrocervical trunk (RTCT) at the same level of origin as the right internal thoracic artery (RITA) and the right costocervical trunk (RCCT). The RTCT gave off the right inferior thyroid artery (RiTA) and the ascending and the transverse cervical arteries. The right suprascapular artery (RSSA) was not a branch of the RTCT and originated from the distal part of the RSCA. The RCCT gave off the deep cervical and the supreme intercostal arteries. The novel variant pattern is classified as a subtype of the Type Y of Hada et al. (10). The ASM compressed the RSCA against the superior part of the first rib. Since the RSCA passed through the anterior and posterior fibres (AF-PF) of the ASM, the compression was not caused solely by the hypertrophic muscle, but also by muscle contraction. The contralateral side had no such variant.

Figure 1. **A.** The right subclavian artery (RSCA), the branch of the brachiocephalic trunk (BCT) is depicted, between the anterior scalene muscle (anterior and posterior) fibres (AF and PF), IJV- internal jugular vein, and T-trachea. The BCT formed a common trunk (CT) with the left common carotid artery (LCCA). The inclination of the trachea (T) at the left side is evident, RSSA- right suprascapular artery, RSSN-right suprascapular nerve, **B.** The RSCA branching pattern (right vertebral artery-RVA, right thyrocervical trunk-RTCT at the same level of origin with the right internal thoracic artery-RITA, RTA-right inferior thyroid artery, RRLN- right recurrent laryngeal nerve passing anterior to the RTCT. **C.** The same level of origin of the RTCT and the RITA. The RRLN passed anterior to the RSCA branches. AF and PF created a musculoaponeurotic tunnel through which the RSCA coursed.

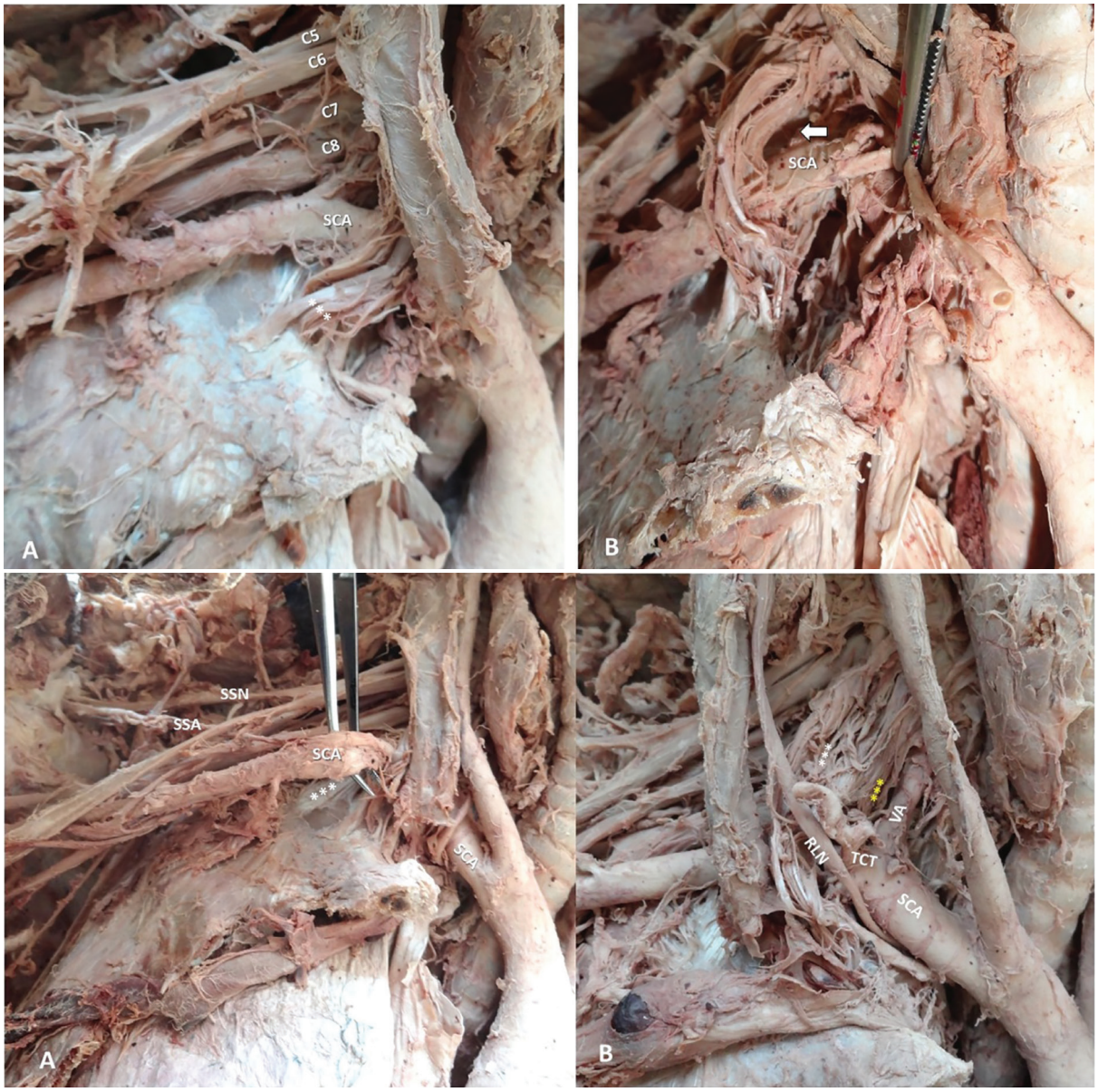

Figure 2. **A.** ***The anterior scalene muscle's anterior fibres (AF) insertion into the 1st rib. A few millimeters below the right suprascapular artery originated (RSSA) and passed between the upper and middle trunks (UT and MT) of the brachial plexus,. accompanied by the right suprascapular nerve and vein (RSSN and RSSV). The area of the internal jugular vein (IJV) and right subscapular vein (RSCV) anastomosis into the venous angle (black arrow) area of the thoracic duct, LT- lower trunk. **B.** Posterior fibres (PF) appear posterior to the right vertebral artery (RVA) origin. The passage of the RSCA through the muscular tunnel and RSCA compression, RRLN-right recurrent laryngeal nerve, RTCT-right thyrocervical trunk, BCT-brachiocephalic trunk.

Discussion

The case is presented of a possible arterial TOS, due to a hypertrophic ASM and the atypical passage of the RSCA through its fibres. The special feature of this case is the variant course of the RSCA through the hypertrophic ASM fibres. Therefore, there were concurrent compression factors, one from the hypertrophic ASM and one from the ASM contractions upon movement. Several rare anomalies have

been discovered and classified in the Roos system, and include cervical ribs, additional tendons, and accessory muscles (12). Several scalene muscle variants found in TOS have also been reported, such as ASM hypertrophy, the passage of the brachial plexus through the ASM, and excessively anterior and middle scalene muscle insertion into the first rib, anomalous fibrous bands within the thoracic outlet, and others (15). A TOS of arterial type may be caused by the variant presented here, although no further details exist from the personal record of the subject.

Several authors have reported 13 isolated cases in their cadaveric studies, with an incidence ranging from 0.2-1.8% (9, 16). Uemura et al. (9) declared that the ASM position in relation to the SCA significantly affects the artery's ramification patterns. Thus, the branching pattern sequence of the current study, not classified into a type, presents similarities to Type Y of Hada et al. (10) and may be a new subtype of it. The developmental mechanism of this type remains unknown.

On the basis of the published literature and the current finding, it is evident that there is the need for a unified classification of SCA pattern types based on the ASM location (anterior to the SCA, posterior to the SCA and passing through its fibres). Larger studies following this protocol could further record common, uncommon and unique variants, and classify them according to the severity of their symptoms.

Conclusion

The current cadaveric report highlights the value of the in-depth knowledge of anatomical variants that may compress the brachial plexus and/or subclavian artery. This knowledge may help clinicians to diagnose neurogenic and arterial TOS. Cases of hypertrophic ASM may act as a compression factor, through the muscular tunnel created surrounding the SCA and its branching pattern.

What Is Already Known on This Topic:

The entrapment and compression of the subclavian artery by a variant form of the anterior scalene muscle may cause arterial thoracic outlet syndrome. The syndrome is characterized by chronic and repetitive artery compression which leads to arterial wall damage, aneurysm, embolization, and thrombosis. It is generally associated with cervical ribs and soft tissue anomalies, such as anterior scalene muscle hypertrophy. Other aetiological factors could be due to first rib anomalies, clavicle fracture, and the presence of fibrocartilaginous bands.

What This Study Adds:

The current cadaveric report presents the rare presence of a unilateral hypertrophic anterior scalene muscle, and the relationship of its fibres with the subclavian artery. Specifically, some muscle fibres create a muscular tunnel, surrounding and compressing the subclavian artery, thus causing a rare form of the arterial type of thoracic outlet syndrome. The subclavian artery is compressed during contractions of the anterior scalene muscle. Special emphasis should be given to the probable presence of variants or accessory muscles inserted into the 1st rib.

Acknowledgments: The authors are grateful to body donors and their families for their continuous contribution to anatomy education and research.

Authors' Contributions: GT and MP undertook the dissection of the cadaver and captured the case; IC and VK performed the acquisition, data analysis, and interpretation, and wrote the paper; TT and DP revised the paper. All authors approved the final form of the draft paper.

Conflict of Interest: The authors declare that they have no conflict of interest.

References

1. Tan TW, Kenney R, Farber A. Left arterial thoracic outlet syndrome. Tex Heart Inst J. 2014;41(1):105-6. doi: 10.14503/THIJ-12-3117.
2. Ernst AJ, Lamb B, White C. Arterial Thoracic Outlet Syndrome in a Runner. Cureus. 2021 May;13(5):e15225. doi: 10.7759/cureus.15225.
3. Ohman JW, Thompson RW. Thoracic Outlet Syndrome in the Overhead Athlete: Diagnosis and Treatment Recommendations. Curr Rev Musculoskelet Med. 2020;13(4):457-71. doi: 10.1007/s12178-020-09643-x.
4. Huang J, Lauer J, Zurkiya O. Arterial thoracic outlet syndrome. Cardiovasc Diagn Ther. 2021;11(5):1118-24. doi: 10.21037/cdt-20-149.
5. Chang KZ, Likes K, Davis K, Demos J, Freischlag JA. The significance of cervical ribs in thoracic outlet syn-

drome. J Vasc Surg. 2013;57(3):771-5. doi: 10.1016/j.jvs.2012.08.110.

6. Farina R, Foti PV, Iannace FA, Conti A, Ferlito A, Conti A, et al. Thoracic outlet syndrome: a rare case with bilateral cervical ribs and bilateral anterior scalene hypertrophy. J Ultrasound. 2021;24(3):331-6. doi: 10.1007/s40477-019-00418-w.
7. Qaja E, Honari S, Rhee R. Arterial thoracic outlet syndrome secondary to hypertrophy of the anterior scalene muscle. J Surg Case Rep. 2017 Aug;2017(8):rjx158. doi: 10.1093/jscr/rjx158.
8. Dalio MB, Filho ERDS, Barufi MB, Ribeiro MS, Joviliano EE. Contemporary Management of Arterial Thoracic Outlet Syndrome. Ann Vasc Surg. 2021;74:42-52. doi: 10.1016/j.avsg.2021.01.078.
9. Uemura M, Takemura A, Ehara D, Yasumitsu H, Ohnishi Y, Suwa F. Comparative study of the ramification patterns of the subclavian branches as the subclavian artery passes in front or behind the scalenus anterior muscle. Anat Sci Int. 2010;85(3):160-6. doi: 10.1007/s12565-010-0072-8.
10. Hada T, Shimamura C, Hayata S, Uemura M, Takemura A. Ramification patterns of the subclavian branches as the subclavian artery passes through the scalenus anterior muscle. Journal of Osaka Dental University. 2019;53(1):49-54.
11. Gkikas A, Lampridis S, Patrini D, Kestenholz PB, Azenha LF, Kocher GJ, et al. Thoracic Outlet Syndrome: Single Center Experience on Robotic Assisted First Rib Resection and Literature Review. Front Surg. 2022;9:848972. doi: 10.3389/fsurg.2022.848972.
12. Archie M, Rigberg D. Vascular TOS-Creating a Protocol and Sticking to It. Diagnostics (Basel). 2017;7(2):34. doi: 10.3390/diagnostics7020034.
13. Illig KA, Donahue D, Duncan A, Freischlag J, Gelabert H, Johansen K, et al. Reporting standards of the Society for Vascular Surgery for thoracic outlet syndrome. J Vasc Surg. 2016;64(3):e23-35. doi: 10.1016/j.jvs.2016.04.039.
14. Sanders RJ, Hammond SL, Rao NM. Diagnosis of thoracic outlet syndrome. J Vasc Surg. 2007;46(3):601-4. doi: 10.1016/j.jvs.2007.04.050.
15. Hooper TL, Denton J, McGalliard MK, Brismée JM, Sizer PS Jr. Thoracic outlet syndrome: a controversial clinical condition. Part 1: anatomy, and clinical examination/diagnosis. J Man Manip Ther. 2010;18(2):74-83. doi: 10.1179/106698110X12640740712734.
16. Yuda K, Kodama J, Nakamura T, Nagato T, Yanagisako M, Toh H. A case of the left subclavian artery passing in front of the scalenus anterior muscle [in Japanese]. J Fukuoka Dent Coll. 2000;27:113-7.