Rare bilateral origin variations of the suprascapular arteries

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A bilateral branching variation of the Suprascapular Artery (SA) was observed in a 75- year-old female cadaver during a routine dissection as a part of the spring 2018 anatomy course. Bilaterally, the SA did not arise from the thyrocervical trunk as it is commonly observed. On the right, the SA originated 13.6 mm from the beginning of the internal thoracic (mammary) artery, a branch of the first part of the right subclavian artery. It traveled further anterior to the lower insertion part of the anterior scalene muscle, lateral to the phrenic nerve, posterior to the medial third of the clavicle and anterior to the distal part of the subclavian artery and brachial plexus. It then crossed over the above structures to meet with the suprascapular nerve and continued along its normal route to the suprascapular notch. On the left, the SA and internal thoracic artery shared a common origin on the first part of the left subclavian artery, and then coursed anterior to the phrenic nerve and distal attachment of the anterior scalene muscle. Later, it followed a similar route as the right SA to the suprascapular notch. On both sides, the SA traveled above the superior transverse scapular ligament, whereas the suprascapular nerve passed below it. The presented anatomical variations of the suprascapular arteries are very rare and are clinically important for making accurate diagnoses, treating clavicle fractures as well as safely performing surgical procedures such as coronary bypass surgery. .

Key Words: *Suprascapular Artery (SA); Internal thoracic (mammary) artery; Thyrocervical trunk; Superficial cervical artery; Coronary bypass surgery*

INTRODUCTION

The branches of the thyrocervical trunk, which is a direct branch of the subclavian artery, are commonly subjected to anatomical variations [1,2]. The subclavian artery can be divided into three distinct parts by the anterior scalene muscle with the first part located medially, the second part situated directly behind it, and the third part positioned laterally. The first part gives off the vertebral artery running superiorly and medially with the internal thoracic artery descending into the thorax, and the thyrocervical trunk running superiorly. Commonly, the thyrocervical trunk arising from the anterosuperior aspect of the subclavian artery is divided into three branches. The lowest branch is typically the SA, the middle branch is the transverse cervical artery, and the superior continuation of thyrocervical trunk the inferior thyroid artery [1,3-5].

After branching from the thyrocervical trunk, the SA takes a lateral path over the anterior scalene muscle and phrenic nerve before crossing over the third part of the subclavian artery and brachial plexus while remaining anterior, or superficial, to all of those structures [3,6,7]. In the region near the inferior belly of the omohyoid muscle, the SA takes a dorsal route where close to the lateral half of the superior border of the scapula it begins to run alongside the suprascapular nerve toward the suprascapular notch of the scapula. There, just medial to the coracoid process of the scapula, the SA typically traverses over the superior transverse scapular ligament, while the suprascapular nerve passes under this ligament to reach the supraspinous fossa. The neurovascular bundle supplies the supraspinatus muscle and then passes through the spinoglenoid notch of the scapula supplying the infraspinatus muscles [3,6,7]. In the dorsal scapular region, several important anastomoses are formed between the SA with the dorsal scapular artery (or deep branch of the transverse scapular artery) and the circumflex scapular branch of the subscapular artery. This creates respectively a collateral blood flow between the first and third parts of the subclavian artery as well as between the first part of the subclavian artery and the third part of the axillary artery [7].

In the present case it was found that the SA does not bilaterally represent a branch of the thyrocervical trunk. Instead, on the right side the SA arose 13.6 mm distal from the origin of the internal thoracic artery, which is coming off the first part of the subclavian artery. The SA arose from the junction of the internal thoracic artery and subclavian on the left side. The reported anatomical variation here bears great clinical significance with respect to correct diagnoses as well as efficient and safe surgical procedures.

METHODOLOGY

The body of a 75-year-old female was received under the Saint Louis University Gift of Body Program of the Center for Anatomical Science and Education (CASE) with an informed consent from the donor. Records indicate this woman's cause of death was a metastatic lung cancer with no other pathologies noted. The cadaveric body was dissected according to guide of Detton [8]. The length and the width of the SA on both sides of the body as well as the distances of its origin from the internal thoracic artery were obtained by electronic caliper (Swiss Precision Instruments, La Palma, CA, part number 13-618-4). The respective numbers are the average of two independent measurements.

CASE REPORT

A bilateral anatomical variation of the SA was discovered during a routine dissection of the subclavian artery and its branches in a 75-year-old Caucasian female cadaver. After cleaning the connective tissue around the structures, it was noted that the SA originated from the proximal part of the inferiorly oriented internal thoracic artery on the right side of the body and from the junction of the internal thoracic and subclavian arteries on the left side. These anatomical variations were observed in addition to the presence of a functioning thyrocervical trunk on the right side and dorsal scapular arteries on both sides of the body (Figure 1).

Additionally, it was determined that the right SA was formed from the internal thoracic artery approximately 13.6 mm distal to its own origin from the right subclavian artery (Figure 1). The artery then coursed superiolaterally to travel anterior to the insertion point of the anterior scalene muscle, lateral to the phrenic nerve, posterior to the medial third of the clavicle, and anterior then superior to the distal subclavian artery and brachial plexus (Figure 1). The SA then met with the suprascapular nerve to continue toward the suprascapular notch as normal, where it passed above the superior transverse scapular ligament, while the suprascapular nerve went under the ligament thereby supplying blood and innervation to the posterior rotator cuff muscles. The width of the right SA was 2.25 mm. The length of the SA from its origin to the suprascapular notch was 90.0 mm (Figure 1).

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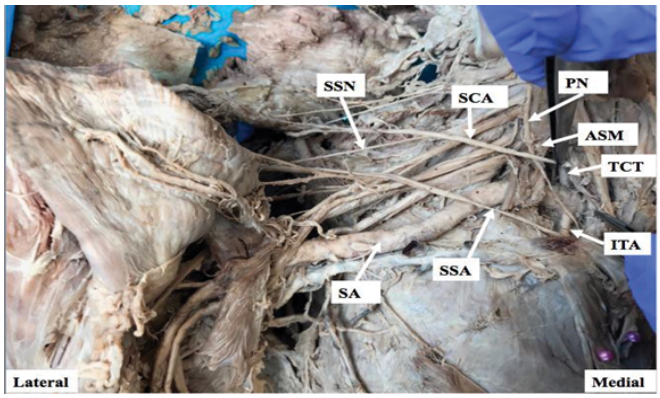

Figure 1) *Illustration shows the right suprascapular artery originating from the internal thoracic artery. ASM, Anterior Scalene Muscle; ITA, Internal Thoracic Artery; PN, Phrenic Nerve; SA, Subclavian Artery; SCA, Superficial Cervical Artery; SSA, Suprascapular Artery; SSN, Suprascapular Nerve; TCT, Thyrocervical Trunk.*

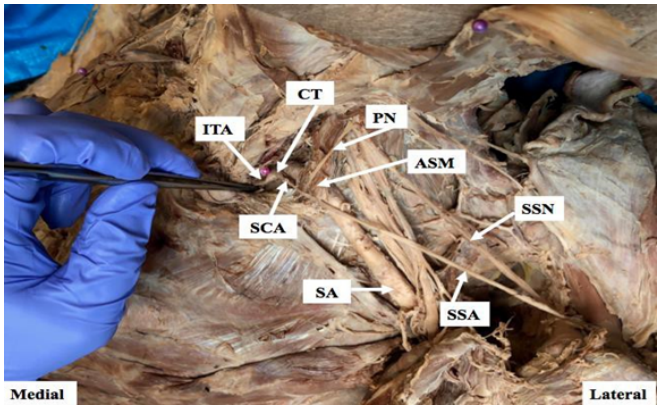

Figure 2) *Illustration shows left suprascapular artery originating from the inferolateral junction of the subclavian artery and the internal thoracic artery. ASM, Anterior Scalene Muscle; CT, Common Trunk; ITA, Internal Thoracic Artery; PN, Phrenic Nerve; SA, Subclavian Artery; SCA, Superficial Cervical Artery (cut off); SSA, Suprascapular Artery; SSN, Suprascapular Nerve.*

The left SA was found to be originated from the inferolateral junction of the subclavian and internal thoracic arteries on the first part of the subclavian artery (Figure 2). Similar to its right counterpart, the left SA also coursed superiolaterally toward the lateral scapula. It traveled anterior to the phrenic nerve and to the insertion point of the anterior scalene muscle and then followed the same path as the right SA. There was a normal anatomical relationship between the SA and nerve with regard to the superior transverse scapular ligament on the left side of the body. The width of the left SA was measured at 2.16 mm. The length of the SA from its origin to the suprascapular notch was approximately 88.0 mm (Figure 2).

Dorsal scapular arteries arising from the third part of the subclavian arteries were found bilaterally and traveled posteriorly to supply the muscles deep to the trapezius muscle, thereby reflecting common anatomical pattern (Figure 2). The remaining branches of the thyrocervical trunk also displayed normal anatomical pattern on the right side whereas no thyrocervical trunk was observed on the left side of the body. Instead, the inferior thyroid artery originated directly from the subclavian artery while the superficial cervical artery arose from the proximal part of the SA (Figure 2). Unfortunately, the examination of the superficial cervical artery anatomy was impossible due to a dissection accident. Normal anastomotic connections between the suprascapular, dorsal scapular and circumflex scapular arteries were found in the posterior aspect of scapular region (Figure 2).

DISCUSSION

Variations are common among branches of the thyrocervical trunk and subclavian artery and can be either unilateral or bilateral in nature. The thyrocervical trunk is the most variable part of the subclavian artery, in which it may commonly have either fewer or more branches compared to normal [2]. A detailed description of alternative branching patterns for the superficial cervical and dorsal scapular arteries could be also found [9].

It should be noted that in approximately 30% of the population, the SA branches as a common trunk with the superficial branch of the transverse cervical artery, which in turn is a branch of the thyrocervical trunk located on the first part of the subclavian artery [10]. An extensive bilateral study of the subclavian artery and its branches in 72 Japanese adults [11] reported similar trends where the SA variants mostly arose as a common trunk or branch of the transverse cervical artery. This form of variation is of minimal clinical interest due to its close similarity to the normal anatomy of this region.

Other variant branching locations have been noted directly from the axillary artery or subclavian artery at a much lower average incidence of around 10% [7,11]. Direct branching of the SA occurs typically from the third part of the subclavian artery and is more common than a direct branching from the axillary artery [3,6,7]. Similar findings were also observed in a study of 50 cadavers (31 adult and 19 fetal), where the SA was a branch of the third part of the subclavian artery or the first, or second part, of the axillary artery. The SA originating independently from the subscapular artery of the third part of the axillary artery was also observed in the 3% of the examined bodies [12]. However, none of those variants originated from the internal thoracic artery [13].

Variation of the SA with an origin from the internal thoracic artery is estimated to occur in 1.8% to 11.5% of the reported cases [14-19]. Usually, the SA arising from the internal thoracic artery has been attributed to the absence of the thyrocervical trunk [18,20]. Our findings as well as the others [16] support the notion that the SA coming off the internal thoracic artery alongside of a function thyrocervical trunk on the ipsilateral side is very rare. When the thyrocervical trunk is present on the ipsilateral side, the incidence of the respective branching pattern should be even smaller. Collateral blood flow between the

first part of the subclavian artery and the third part of the axillary artery around the scapula is still preserved in this variation since the internal thoracic artery medial to the anterior scalene muscle is branching from the first segment of the subclavian artery. Cases of bilateral duplicated SA have been reported with the one arising from the thyrocervical trunk and another one stemming from the third part of the subclavian artery [11]. The same research group also observed that the suprascapular artery may be absent in 3% of the cases.

The significance of the present case is severalfold. First, a correct knowledge of variant branching patterns of the suprascapular artery is very important for carrying out surgical, interventional, and diagnostic procedures in the heart, neck and shoulder regions where the aforementioned anatomical variations are present [1,3,21]. Indeed, coronary bypass surgery utilizes the internal thoracic artery as a graft in a majority of the 800,000 procedures performed each year worldwide because of far superior benefits over the use of the saphenous vein. Therefore, the correct knowledge of the internal thoracic artery anatomical variations would be essential for a successful grafting distal to the SA origin [16].

Second, the orthopedic and plastic/reconstructive surgeons could face unexpected difficulties ligating the SA during procedures involving the neck and shoulder regions when the SA would stem from the internal thoracic artery. Such surgeries may include radical and modified neck dissections, rotator cuff surgery as well as the procedures where musculocutaneous flaps or grafts are created from muscles such as the trapezius or the sternocleidomastoid ones.

Third, the respective anatomical variations must be taken into consideration while performing the SA ligation for the neck lymphoma containment [11,16] as well as avoiding SA damage during lymph node biopsy or caring for a trauma in the posterior triangle of the neck.

Fourth, clavicle fractures tend to be extremely common and break near the midpoint of the bone without injuring SA. However, this might not be the case when the SA branches from the internal thoracic artery and courses obliquely deep to the posterior middle third of the clavicle where it reaches the suprascapular notch [7,13,16].

Fifth, this uncommon branching pattern may disrupt collateral blood circulation in the shoulder and cause suprascapular neuropathy due to the entrapped vessels thereby leading to microemboli in the vasa nervorum of the suprascapular nerve [1,3,16,21]. Most notably, for the SA originating from the axillary artery the muscles of the rotator cuff group (supraspinatus and infraspinatus muscles) could be deprived of blood flow if the axillary artery becomes congested or kinked. This could happen due to the anastomosis formed by SA with the circumflex branch of subscapular artery branching from the third part of the axillary artery. This could be especially

true when the SA arises from the third part of the axillary artery [3,12]. In the latter case, the majority of the blood supply to the shoulder region could be compromised. One should be also aware of additional variations of the branches of the third part of the axillary artery, including that of posterior humeral circumflex artery [12,22,23]. Due to its close proximity to the SA, any surgical procedure causing occlusion of the posterior humeral circumflex artery may lead to the quadrangular space syndrome [24,25-28].

Finally, each additional uncommon branching pattern of the SA increases a chance of unconventional interaction between the SA and the nerve during the creation of the superior transverse suprascapular ligament, particularly when the SA directly branches from the subclavian or axillary arteries. This could lead to suprascapular entrapment neuropathy when the SA passes inferior to the ligament and compresses the suprascapular nerve. Therefore, any additional knowledge regarding the extent of the variations of the SA branching patterns is of significant clinical value.

CONCLUSION

The reported variable branching patterns of suprascapular arteries are important for health care practitioners allowing optimization the respective clinical diagnoses and procedures.

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