Original Article

Surgical & Embryological Significance of Subclavian Artery Branching Profile – Cadaveric Study

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Abstract

Background: Studying the variations of branching pattern of subclavian artery & their relations to brachial plexus are surgically relevant due to utilization of its branches in different operative procedures involving head, neck, thorax & back region. **Aims & objectives:** Aim of the present study was to explore the variations in the branching pattern of the subclavian artery at the root of the neck & calculate the prevalence of such variations. **Material and Methods:** Cadaveric dissection-based Cross sectional observational study was conducted in a medical college of West Bengal. During routine dissection for undergraduate medical students from two sessions, branching pattern of subclavian artery at scaleno-vertebral triangle were studied in 22 adult formalin fixed cadaver of both sexes. All the variations were recorded & their prevalence was calculated & the findings were compared to previous studies. **Results:** In one out of 44 cases Scalene anterior muscle passed behind the subclavian artery. Typical branching pattern of thyrocervical trunk was recorded in 63.6% cases which is almost similar to the findings of Vyas et. al. In 15.9% cases costocervical trunk was absent, where its branches directly arose from subclavian artery. Suprascapular artery was absent in 6.81% cases. DSA was most commonly arising from cervico-dorso-scapular trunk (70.45%) cases. **Conclusion:** Proper pre-operative evaluation of subclavian artery branching pattern must be done by angiography or doppler before approaching for any vascular intervention because branching pattern of subclavian artery varies in most of the cases.

Keywords: Subclavian artery, Dorsal Scapular artery, Thyrocervical trunk, Myocutaneous flap, Branching.

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Introduction

Subclavian artery (SA) arises from brachiocephalic trunk on right side & from arch of aorta on left side. Subclavian artery is divided into 3 parts by scalene anterior muscle. First part of SA extends from its origin to medial border of scalene anterior muscle & gives 3 branches, namely Vertebral artery, Internal thoracic artery & Thyrocervical Trunk.[1]

Vertebral artery arises from 1st part of SA, ascends upward & passes through the foramen transversarium of C6 to C1, then curves medially behind lateral mass of atlas & enters the cranium via foramen magnum. Internal thoracic artery arises inferiorly from the first part of the subclavian artery, 2cm above the sternal end of the clavicle, opposite the root of thyrocervical trunk. Thyrocervical trunk arises from anterior aspect of first part of subclavian artery & divides almost immediately into inferior thyroid artery, suprascapular artery & superficial cervical artery. Inferior thyroid artery ascends upward along the anterior aspect of medial border of scalene anterior muscle, makes a loop at the level of C6 transverse process & descends downward on longus coli up to lower border of thyroid gland. Here it passes between vertebral artery behind & carotid sheath with its contents in front. Suprascapular artery descends laterally across the phrenic nerve & scalene anterior. Superficial cervical artery arises at a higher level & ascends across the floor of the posterior triangle to reach the anterior margin of levator scapulae.[1]

The second part of the SA runs behind scalene anterior, gives rise to costo-cervical trunk (arises from first part of artery on left side). Costo-cervical trunk (CCT), arches back above the cervical pleura up to the neck of first rib, where it divides into the deep cervical artery & superior intercostal artery.[1]

3rd part-from lateral border of scalene anterior to outer border of 1st rib, which gives rise to dorsal scapular artery (DSA), which passes laterally through the brachial plexus in front of scalenus medius, then passes deep to the levator scapulae to the superior angle of scapula.[1]

Variations of the branching pattern of subclavian artery are not rare and recorded by many authors previously. The arteries of the posterior triangle of neck are frequently used in plastic and reconstructive surgery for artery-based pedicular flaps, like superficial cervical artery-based cervico-dorsal or cervico-scapular perforator musculocutaneous flaps or lower trapezius perforator myocutaneous flaps.[2,3] Trapezius myocutaneous flap surgery is a common operative procedure done for repairing the

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defects in head & neck region. Internal thoracic artery is commonly used for coronary artery bypass grafting & it presents many anatomical variations in its origin & courses. Though real incidences of such anatomical variations have not been recorded yet, many case reports & studies are available depicting variations of ITA.[4]

Variations of branching pattern of subclavian artery & its relations to brachial plexus may pose a potential risk for nerve compression and increase the risk of artery and nerve puncture during different operative procedures. Early detection of these variations through diagnostic interventions is helpful to reduce postoperative complications.[5]

The ITA also lies in close vicinity to phrenic nerve causing partial paralysis of diaphragm when ITA is harvested for CABG. Moreover, the site of origin is in close vicinity to the Subclavian vein, which is commonly used for percutaneous subclavian vein catheterization to determine central venous pressure and to administer drugs and solutions in an emergency. It is also used in introducing a pacemaker. Internal thoracic artery is the main source of blood supply to sternum, and any damage to this supply results in sternal wound complications.[6,7]

Materials and Methods

A dissection & observation-based study was conducted in the Department of Anatomy, NRS Medical College and Hospital, Kolkata, between May 2024 to April 2025 on donated cadavers. After taking clearance from institutional ethical committee, the cross- sectional observational study was conducted on both the sides of 22 adult formalin-fixed cadavers of both sexes (5 females, 17 males) of ages ranging between 50 to 75yrs. All the cadavers studied in present case were residents of the Eastern India zone. All the cases with congenital anomalies, deformities, injuries and operations in and around neck region were excluded from the study.

After placing the cadaver in dorsal decubitus position with neck extended to opposite side, posterior triangle of neck region was dissected. After removing skin & platysma, the investing layer of deep cervical fascia was cleared off. We used blunt dissection method to clean inferior belly of omohyoid muscle. Fascial sling that binds the intermediate tendon of omohyoid to the clavicle was cut. Scaleno-vertebral triangle was dissected & cleared. Subclavian vein & Subclavian artery with its branches were dissected, identified & photographed.

Data analysis: All the collected data was compiled in MS excel sheet & described by proportion by its sides. Data display was done by framing appropriate tables.

Results

Results & observation: n=44 arteries

A. **Relation of Scalene anterior muscle to Subclavian artery:** Out of 44 specimens (22 cadavers) in one case Scalene anterior muscle passed behind the artery .in rest of the cases it passed in front of the artery.

B. **Branching pattern of subclavian artery:** Branching pattern of subclavian artery and proportion of individual findings: In Present study, Internal thoracic artery & Vertebral artery originated from first part of the Subclavian artery in 100% cases.

Variations of thyrocervical artery: Typical branching pattern of thyrocervical trunk was noted in 63.63% cases [Figure 3]. In 9.09% cases TCT was absent & its branches originated from Subclavian artery directly. [Figure 1] In 12.27% cases suprascapular artery was missing from TCT [Figure 4-7 & [Table 1]

Table 1: showing distribution of branching pattern of thyrocervical trunk

Artery	Branching pattern	Incidence		
Thyrocervical trunk	Typical branching pattern	28(63.63%)	R	15(34.09%)
			L	13(29.54%)
	Absent typical origin of suprascapular artery from thyrocervical trunk	12(27.27%)	R	6(13.63%)
			L	6(13.63%)
	Absent TCT & its branches arising from Subclavian artery directly	4(9.09%)	R	2(4.54%)
			L	2(4.54%)

Variations of costo-cervical trunk: Commonly originated from Subclavian artery in 84.09% cases, absent with branches arising from subclavian artery in 9.09% cases & superior intercostal artery arising from thyrocervical trunk in 6.81% cases. [Figure 4], [Table.2]

Table 2: showing distribution of branching pattern of Costo-cervical trunk

Artery	Branching pattern	Incidence		
Costo- cervical trunk	Normal origin	37(84.09%)	R	17(38.64%)
			L	20(45.45%)
	Absent with branches directly arising from subclavian artery	4(9.09%)	R	3(3.81%)
			L	1(2.27%)
	Absent with superior intercostal artery arising from thyrocervical trunk	3(6.81%)	R	1(2.27%)
			L	2(4.54%)

Variations of suprascapular artery: Suprascapular artery originated from thyrocervical trunk in 72.72% cases, but in 20.45% cases it originated from other branches of Subclavian artery & was absent in 6.81% cases (case 7). [Table.3]

Table 3: showing distribution of branching pattern of Supra-scapular artery

Artery	Branching pattern	Incidence

Suprascapular artery	Normal origin-Arising from Thyrocervical trunk	32(72.72%)	R	17(38.64%)
			L	15(34.09%)
	Arising from other branches of subclavian artery	9(20.45%)	R	3(6.81%)
			L	6(13.63%)
	Absent suprascapular artery	3(6.81%)	R	3(3.81%)
			L	0(0%)

Variations of Dorsal Scapular artery: Dorsal scapular artery originated from 3rd part of SA in 70.45% cases followed by cervico-dorsal trunk (which originated from thyrocervical trunk) in 20.45% cases. In 4.54% cases DSA originated from Cervico-dorso-scapular trunk [Figure1] & in 4.54% it originated from dorso-scapular trunk. [Figure 2 & Table.4]

Table 4: showing distribution of branching pattern of Dorsal scapular artery

Artery	Branching pattern	Incidence		
Dorsal Scapular artery	Normal origin-Arising from 3rd part of SA	31(70.45%)	R	17(38.64%)
			L	14 (31.81%)
	From Cervico-dorsal trunk from TCT	9(20.45%)	R	4 (9.09%)
			L	5(11.36%)
	From Cervico-dorso-scapular trunk	2(4.54%)	R	2(4.54%)
			L	0(0%)
	From Dorso-scapular trunk from SA	2(4.54%)	R	2(4.54%)
			L	0(0%)

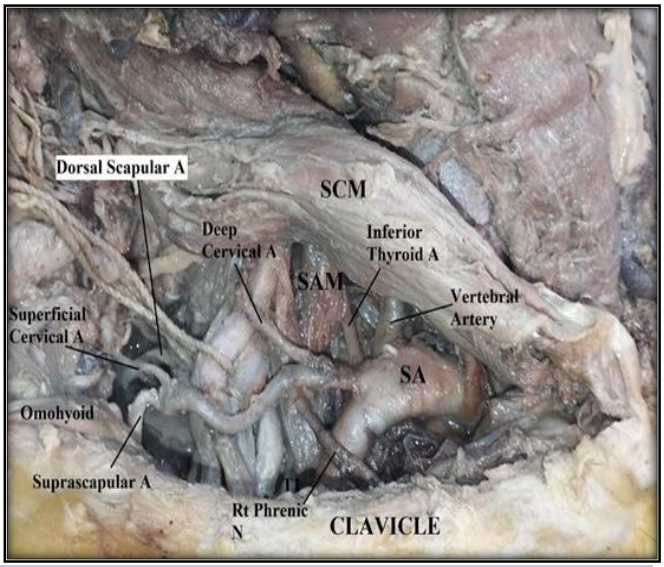

Figure 1: Side: Right. One common arterial trunk raised from proximal part of subclavian artery, which divides into 4 branches – deep cervical, superficial cervical, suprascapular & dorsal scapular arteries. Thyrocervical trunk was absent, and inferior thyroid artery directly originated from proximal part of subclavian artery. No branches from distal subclavian artery. Rest of the branches were normal.

Here scalene anterior muscle originated from 3RD to 6TH cervical vertebrae, descended downward in front of trunks of brachial plexus, behind the subclavian artery (instead of anterior to) and was inserted into scalene tubercle.

-Right phrenic nerve was passing in front of subclavian artery, lying in direct contact.

-Ventral rami of T1 were passing between scalene anterior and Scalene Medius.

Inferior belly of omohyoid has been cut from common tendon and reflected laterally for a better view.

SCM: Sternocleidomastoid, SAM: Scalene Anterior muscle, SA: Subclavian artery.

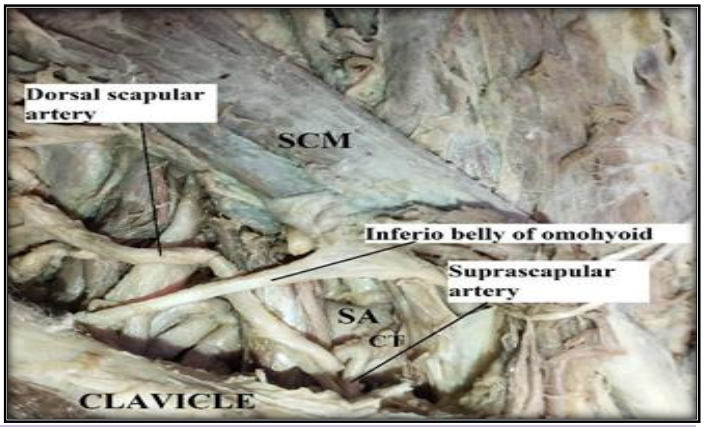

Figure 2: Side: Right.Common arterial trunk (Dorso-scapular) arising from first part of subclavian artery which is dividing into Dorsal scapular artery & suprascapular artery. (Right side) Inferior thyroid artery arising from first part of subclavian artery.

SA: Subclavian artery, CT: Common trunk

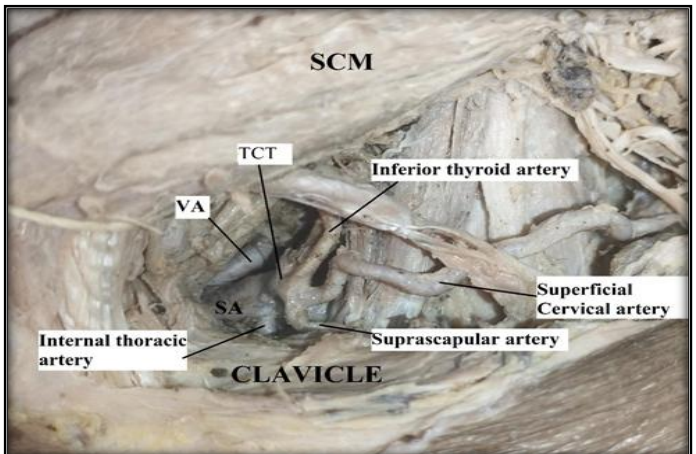

Figure 3: Side: Left.From first part of SA, Thyrocervical trunk(TCT) is arising, giving rise to Superficial Cervical, suprascapular & inferior thyroid artery. (Left side).

VA= Vertebral artery; CT=Common trunk; SA=Subclavian artery; SCM=Sternocleidomastoid

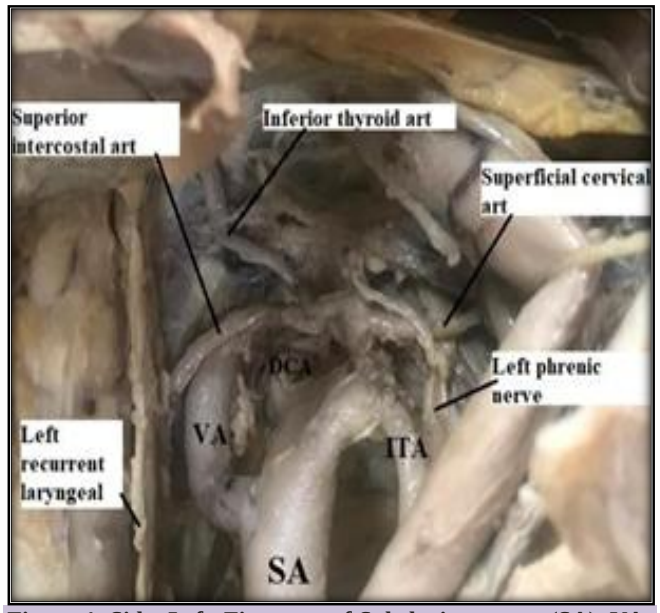

Figure 4: Side: Left. First part of Subclavian artery (SA), VA: Vertebral artery, DCA: Deep cervical artery, ITA: Internal thoracic artery.

On left side costo-cervical trunk was absent. Deep cervical artery was arising from Subclavian artery directly & superior intercostal artery was arising from thyrocervical trunk, but suprascapular artery was not arising from TCT. Superficial cervical artery was passing in between the phrenic nerve (C3, C4 root) & C5 root of accessory phrenic nerve, which was joining the phrenic nerve after passing in front of superficial cervical artery.

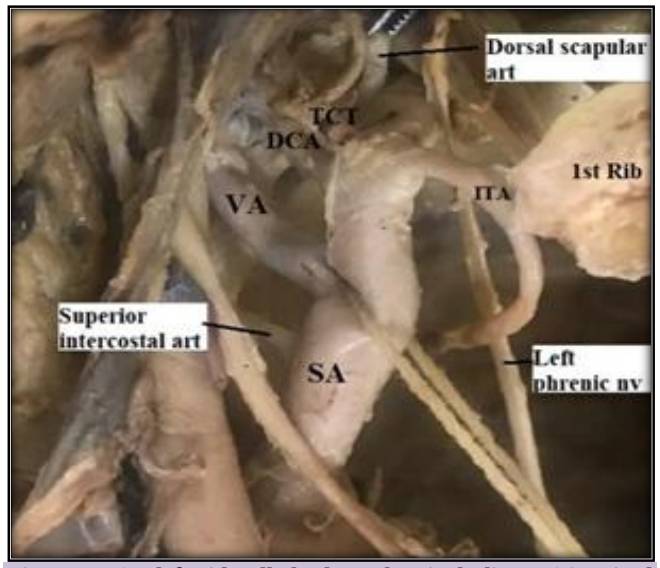

Figure 5: On left side all the branches including DSA raised from first part of subclavian artery. Absence of costo-cervical trunk. Absent suprascapular from TCT. SA: Subclavian artery, VA: Vertebral artery, DCA: Deep cervical artery, ITA: Internal thoracic artery, TCT: Thyrocervical trunk.

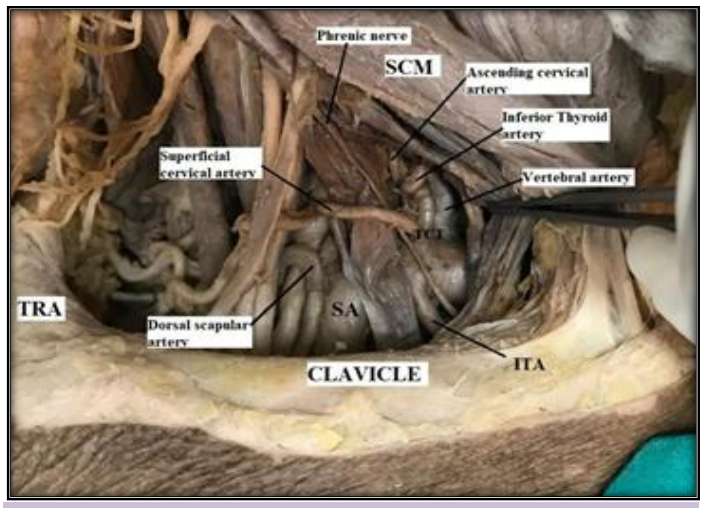

Figure 6: Side: Right.Absence of suprascapular artery from thyrocervical trunk. Rest of the branches are having normal origin & course.

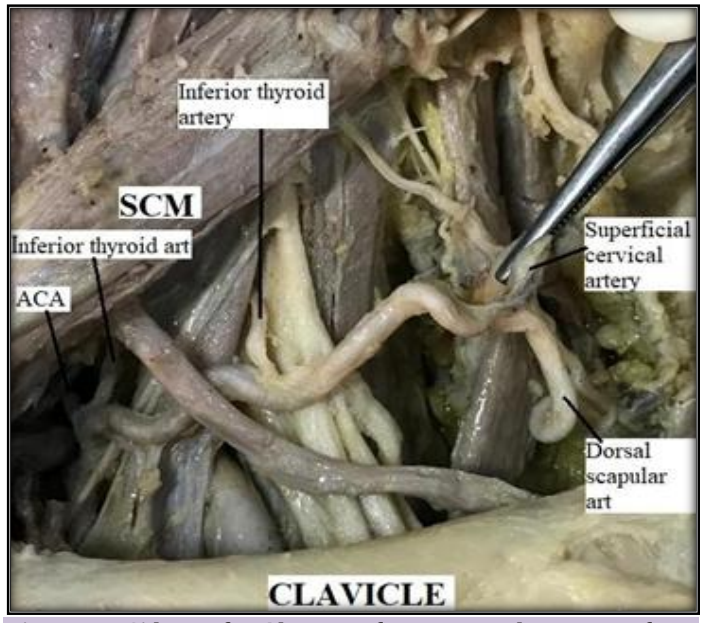

Figure 7. Side: Left. Absence of suprascapular artery from thyrocervical trunk(TCT). Superficial cervical artery & Dorsal scapular artery having a common origin from TCT as transverse cervical artery. Presence of double inferior thyroid artery arising from TCT, one passing medial to scalene anterior muscle & one passing lateral to Scalene anterior & entering the lower pole of thyroid gland separately.

Discussion

Scalene anterior muscle usually passes in front of subclavian artery & divides it into 3 parts. Takafuji T et al. reported that in 1 case out of 144 cases subclavian artery passed in front of scalene anterior (SA) muscle & in another case, it passed through the SA muscle.[8] During the course of development primordium of scalene anterior muscle develops encircling the subclavian artery antero-posteriorly. During development, the posterior fibres disappear and normal adult pattern persists (type I). But when the embryological pattern persists, it gives rise to a transfixed subclavian artery within the muscle fibers of scalene

anterior (Type II). On rare occasion, the anterior fibers disappear and the muscle goes entirely posterior to the subclavian artery (type III).[8] Similar findings of a type III pattern of subclavian artery were also reported by other authors previously.[9,10] In present study only in one out of 44 cases the scalene anterior muscle passed behind the subclavian artery, representing similar incidence pattern like previous studies.

Kumar N et al. reported a case where on both the sides they recorded the presence of cervico-dorso-scapular trunk arising from first part of subclavian artery, which passed in front of the scalene anterior muscle and divided into superficial cervical, suprascapular & dorsal scapular arteries just anterior to trapezius muscle. Thyrocervical trunk & transverse cervical arteries were absent on both sides. All branches of subclavian artery arose from its first part, including the inferior thyroid artery.[9]

Zheng Y et al. reported a case where the internal thoracic artery, the thyrocervical trunk, and the costocervical trunk arose from the third part of the right subclavian artery, phrenic nerve was displaced remarkably laterally by the thyrocervical trunk, and Costo- cervical trunk was passing between the upper trunk and the middle trunk of the brachial plexus.[5]

Manyacka Ma Nyemb P et al. classified the branching patterns of subclavian artery into 9 types, (A to I) with the most common being type D, where the Cervico-scapular trunk arising from the thyro-cervical trunk is present in 28%, followed by Type A, with separate origin of superficial cervical, dorsal scapular and suprascapular arteries noted in 19% cases and type C, with Cervico-dorsal trunk from Subclavian artery recorded in 15% cases.[11]

Weiglein et al. conducted a study on 70 human cadavers to investigate the feeder vessel pattern of the muscle & they noted that muscular branch of dorsal scapular artery to trapezius is always a constant finding, though the origin of dorsal scapular artery itself varies. In 45% cases, the dorsal scapular artery was raised from subclavian artery or costo-cervical trunk, but in majority of the cases, i.e., 55% the dorsal scapular artery formed different trunks with the superficial cervical artery and/or suprascapular artery branching off either the subclavian artery, the thyrocervical trunk, or the internal thoracic artery.[3]

When the DSA arises from the transverse cervical artery, it passes superficial to the trunks of brachial plexus (97%), but in 75% & 100% cases, DSA passes through the brachial plexus when it arises from third & second parts of subclavian artery, respectively. Adequate circulation through the DSA helps in survival & acceptance of trapezius flap. Though it is not proven that the passage of DSA through brachial plexus compresses the artery in any way, but intraoperative inadvertent injury to the artery may change the post-op outcome.[12] Similarly suprascapular artery may show variations in its origin & course. When the artery arises from thyrocervical trunk or transverse cervical artery, it passes superficial or deep to the trunks of brachial plexus, but when it arises from subclavian artery, the SSA passes through the brachial plexus (33%).[12]

In the present study, we recorded that in 70.45% cases, DSA arose from subclavian artery & passed through brachial plexus. Therefore, prevalence of such presentation must be kept in mind before planning trapezius-based myocutaneous flap surgery or brachial plexus block or, other surgeries in the posterior neck region.

Vyas J M V et al. conducted a cadaveric study on 32 subclavian arteries to explore their variation in origin, insertion, course & branching pattern. They classified the branching pattern into 3 types. Thyrocervical trunk arose from first segment of subclavian artery in all the cases except one out of 32, where it was absent & all its branches arose from first segment of subclavian artery. Ascending cervical artery arose from inferior thyroid artery in 65.62% cases & from thyrocervical trunk in 34.37% cases. The TCA and SSA exhibited stereotypical origin from the TCT in 28 arteries and 29 arteries, respectively.[13]

Peric M et al. documented abnormal origin & branching of ITHA (Internal Thoracic artery) occur in 11.25% cases.[7] Panakkal BJ et al. reported a case where left ITA arose from a common trunk of transverse cervical artery & suprascapular artery, but inferior thyroid artery directly arose as first branch from subclavian artery. Right ITHA originated as a common trunk with suprascapular artery.[8] Paraskevas et al. reported a cadaveric case in 2012, where they found ITHA arose from thyrocervical trunk on the left side, which was a common trunk of inferior thyroid artery & suprascapular artery, with the ascending cervical artery arising from the inferior thyroid artery. After originating, ITHA descends downward in front of Subclavian artery to enter thorax.[14]

A rare variation of common arterial trunk of internal thoracic artery & thyrocervical trunk with its branches from left subclavian artery was reported by Westrych K et al., which was supplying the internal thoracic artery & trapezius. Presence of such an arterial trunk can be challenging for surgeons during trapezius myocutaneous flap elevation, as it may result in vascular impairment of anterior thoracic wall in the post-operative period.[15]

In one case, we recorded the presence of cervico-dorso-scapular trunk arising from the first part of subclavian artery, which divided into dorsal scapular, superficial cervical & suprascapular arteries, similar to the findings by Kumar N in a cadaver with a similar presentation on both sides.

In a previous study conducted by Delmotra et al., internal thoracic artery originated directly from first part of subclavian artery in 55 dissections (91.7%). In rest of the five sides, it was a variant origin in common with one or the other branch of thyrocervical trunk, i.e., in common with suprascapular artery in 1.67% cases, with transverse scapular & transverse cervical artery in 3.3% cases, & with suprascapular & superficial cervical artery in 3.3% cases.[16]

- Jorge A. Henriquez-Pino et al. recorded that in 70% & 95% cases, ITA originated from subclavian artery on the left and right sides respectively. In rest of the cases, the artery originated as a common trunk, most commonly with suprascapular artery or with suprascapular and transverse cervical artery.[17-19]
- Absence of costocervical trunk was noted by Bonczar et al in 23.94% cases which is higher than the percentage of present case.[20]

Sl no.	Artery	Study	Population	Finding
1.	ITA origin	Perić M et.al,[4]	Serbia	• Abnormal origin & branching -11.25%
		Panakkal BJ et.al,[18]	India	• Left ITA- from a common trunk of transverse cervical artery & suprascapular artery. • Right ITA- From a common trunk with suprascapular artery
		ParaskevasG et.al,[14]	Greece	• ITA arising from TCT on left side, which was a common trunk of inferior thyroid artery & suprascapular artery, with the ascending cervical artery arising from the • inferior thyroid artery.
		Takafuji T et al,[8]	Japanese	• Arises from SA- 87.5%
		Delmotra et al,[16]	India	• 1st part of subclavian artery-91.7% • In common with suprascapular artery- 1.67% • Common trunk of ITA, Transverse scapular & transverse cervical artery-3.3% • Common trunk of ITA, Suprascapular & Superficial cervical artery- 3.3%
		Present Study	India	• Originated from first part of subclavian artery -100% cases
2.	TCT	Ostrowski,[19]	Poland	• Type 1: TT originated from the SA. TT divided into SSA, which sprouted as the first branch, and a further common trunk for ITA and TCA:26.8% • Type 2: TT originated from the SA. TT divided into ITA, SSA, and TCA without a common trunk for any of the arteries:26.8% • Type 3: TT originated from the SA. TT divided into a further common trunk for SSA and TCA, which sprouted as the first branch, and an ITA:22% • Type 4: TT originated from the SA. TT divided into ITA and TCA:13.4% • Type 5: Any other arrangement:11%
		Vyas et al,[13]	India	Type I: Typical branching pattern of TCT:62.5% Type II: ACA directly arises from TCT :34.37% • Type III:TCT absent &its branches directly arises from first segment of subclavian artery : 3.12%
		Present study	India	• Typical branching pattern: 63.63% • Absent typical origin of suprascapular artery- 27.27% • Absent TCT with branches arising from Subclavian artery directly- 9.09%
3.	CCT	Takafuji T et al,[8]	Japanese	• 22.9% cases -Arises from the first part of SA (More on left) • 42.4% cases-Arises from second part of SA (More on the right)
		Bonczar et al,[20]	Poland	• Typical presentation-76.1% • Absent in-23.94%
		Present study	India	• Normal origin-84.09% • Absent with branches directly arising from subclavian artery-9.09% • Absent with superior intercostal artery arising from thyrocervical trunk-6.81%
4.	SSA	Bean RB	Negros & whites	• From TCT -34%
		Takafuji T et al,[8]	Japan	• Frequent from TCT-38.2%
		Vyas et al,[13]	India	• From Thyrocervical trunk -90.6%
		Present study	India	• From TCT- 72.72% • Arising from other branches of subclavian artery-20.45% • Absent suprascapular artery-6.81%
5.	DSA	Manyacka Ma et al,[11]	Senegal	• From Cervico-dorso-scapular trunk-28% • From Cervico-dorsal trunk from TCT-10% • From Cervico-dorsal trunk from SA-15% • From SA-19%
		Weiglein, A et al,[3]	Austria	• Direct branch from SA or costocervical trunk -45% • From a trunk having common origin with suprascapular artery or superficial cervical artery-
		Kuen-Cherng Lai et.al,[12]	Taiwan	• Branch of Transverse cervical artery-48% • Branch of 2nd part subclavian artery-22% • Branch of 3rd part subclavian artery-25% • Branch of axillary artery-5%
		Maheshwari J et al,[18]	INDIA	• Arises from third part of SA-65.6%
		Present study	India	• From cervico-dorso-scapular trunk-70.45% • From cervico-dorsal trunk from TCT- 20.45% • From dorso-scapular trunk from SA- 4.54% • Branch from 3rd part of SA- 4.54%

Incidence of recurrent massive hemoptysis was reported due to presence of aberrant bronchial artery arising from thyrocervical trunk which was effectively controlled by embolization using gelatin sponge & metallic coil.[21] But before embolization one thing must be kept in mind that, anterior spinal arterial trunk receives radiculo-medullary arteries arising from the neck arteries, including the thyrocervical trunk (ascending cervical branch), because injudicious embolization of TCT may result into neurological consequences also.[22]

Limitations of the Study: As the branching pattern of subclavian artery was recorded in the scaleno-vertebral triangle mainly, so, the cases where suprascapular artery was not visualized within the territory, needed to be traced further, to find whether it arises from Subclavian artery further distally or from axillary artery. Moreover, detailed study of dorsal scapular artery

needs further exploration of posterior triangle extending deep to trapezius & rhomboids.

Conclusion

The ramification pattern of subclavian artery is always different in those cases where scalene anterior muscle passes behind the subclavian artery. Proper preoperative evaluation of subclavian artery branches specially the thyrocervical trunk, must be done to avoid any complication due to its variant branching pattern & anastomosis. Absence of thyrocervical trunk with origin of its branches directly from SA is not very rare which, may complicate thyroid surgeries or surgeries involving the root of neck. Moreover, before taking DSA-based myocutaneous flaps & handling ITA, subclavian artery angiography is recommended for best outcome. In case of rapidly expanding cervical hematoma developed after any surgical procedure (major/minor) first thing to explore, is the subclavian artery & its branches at the root of neck.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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