The Blood Supply of the Sternocleidomastoid Muscle and Its Clinical Implications

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Background: The knowledge of the exact anatomy of the sternocleidomastoid (SCM) muscle and its nerve and blood supply must be considered a basic prerequisite for its use as a pedicle muscle flap.

Objective: To give an exact description of the courses and variability of all vessels supplying the SCM muscle.

Design: Anatomic analysis of all arteries supplying the SCM muscle.

Setting: The blood supply of the SCM muscle was studied by dissecting bilaterally the anterior regions of the neck of 31 perfusion-fixed human cadavers of both sexes aged 50 to 94 years (mean, 78 years).

Results: The blood supply to the SCM muscle can be divided into 3 parts: upper, middle, and lower. The upper third of the SCM muscle was found to be constantly supplied by branches of the occipital artery. According to their courses, these branches are categorized into types 1, 2a, 2b, and 3. The middle third of the SCM muscle receives its blood supply from a branch of the superior thyroid artery (42%), the external carotid artery (23%), or branches of both (27%). In most cases, the lower third of the muscle was supplied by a branch arising from the suprascapular artery (>80%), which has not been described until now.

Conclusions: In contrast to available data, the arterial blood supply of the lower third of the SCM muscle is constantly provided by a branch of the suprascapular artery. Since the SCM muscle flap is used in reconstructive surgery of the neck, the exact knowledge of its blood supply may help to minimize the risk of flap necrosis after surgical procedures.

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At the beginning of this century, Jianu[1] first described the applicability of the sternocleidomastoid (SCM) muscle for locoregional tissue transfer. Later, the SCM muscle had been used to reconstruct defects after resection of the mandible, the floor of the mouth, and the tongue, or to close pharyngoesophageal and tracheal fistulae.[2-8] The SCM muscle has offered vascular neck protection after radical lymph node dissection of the neck and also may help to prevent Frey syndrome in cases of facial paralysis.[9,10] There are several reasons for the application of the SCM muscle for tissue repair: (1) the muscle is richly vascularized, (2) it can be used as a myocutaneous flap, (3) each of its 2 heads can be shifted separately, and (4) the cosmetic results are satisfactory. However, the success rate of the SCM muscle flap lags behind other frequently used flaps in head and neck surgery.[10] It has been shown that necrosis of the SCM muscle flap due to insufficient perfusion limits its use in reconstructive surgery.[11-13] Therefore, it is of importance to have a thorough understanding of the anatomy and vascular supply of the SCM muscle. Although many authors have mentioned the arterial blood supply of the SCM muscle, we found no detailed anatomically based work on this subject. Most notably, available data about the vessels supplying the lower third of the muscle are incomplete, confusing, and sometimes contradictory.[14-17] Therefore, the aim of this study was to further improve the success rate of this flap by determining the exact courses and variability of vessels supplying the SCM muscle.

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RESULTS

The blood supply to the SCM muscle can be divided into 3 parts: an upper, a middle, and a lower part, each being supplied by at least 1 main artery (**Figure 1**).

The upper third of the muscle was supplied by branches of the occipital artery. These branches can be further divided into 3 categories[18]: smaller upper branches (**Figure 2**, A, 1), which were present in 26 right and 27 left preparations, represent-

MATERIALS AND METHODS

Thirty-one necks (61 preparations) taken from 31 human bodies of both sexes (20 male and 11 female), aging from 50 to 94 years (mean, 78 years), donated to our institute were dissected. The cadavers were fixed by perfusion through the femoral artery with a mixture of 4% phenolic acid and 0.5% formaldehyde as standard for dissection methods. Individuals with any signs of severe disease or previous operation on the neck were excluded from this study. The anterior and posterior triangles of the neck were completely dissected by one of us (A.C.K. or M.A.), who documented his findings immediately. Results were reviewed by the other authors independently. In addition, sketches were drawn of all preparations and photographs were taken of all representative cases as well as exceptional cases.

ing 87% for each side. In addition to these tiny branches, a single well-developed branch was found in 10 cases (33%) on the right side and in 12 cases (39%) on the left side (Figure 2, A, 2). In 8 specimens on the right side and 6 specimens on the left side, this artery takes a course parallel to the spinal accessory nerve. In 1 right and 1 left preparation there existed a lower branch (Figure 2, A, 3).

The middle third of the SCM muscle mostly receives its blood supply from 1 branch of the superior thyroid artery and the external carotid artery. In nearly one third of the specimens (8 [27%] on the right side and 8 [26%] on the left), these 2 arteries almost equally shared the blood supply. In the remaining 45 cases, a single branch of either the superior thyroid artery (12 [40%] on the right side and 14 [45%] on the left) or the external carotid artery (23% each side [7 cases each]) was the only nutritive vessel for this part of the muscle (Figure 2, B). In 12 preparations, the branch arising from the external carotid artery had a very characteristic course. Ascending for a short distance in a cranial direction, it wound around the hypoglossal nerve loop and descended subsequently along the anterior margin of the SCM muscle for approximately 2 cm. In most of the cases (n = 10), it entered the muscle between its upper and its middle third parts (Figure 2, B).

In 1 case, the blood supply of the midportion of the SCM muscle was provided by a branch of the lingual artery and the external carotid artery. Both arteries take the characteristic course around the loop of the hypoglossal nerve. In this particular case no branch of the superior thyroid artery was observed.

In 34 preparations we took special attention to branches arising from the ascending cervical artery. Since some of these branches are very thin, this step of preparation was done by means of a microscope. However, in 26 preparations (77%), a few very tiny branches heading toward the SCM muscle could be found.

The lower third of the SCM muscle showed a unique blood supply. We found a branch of the suprascapular artery that showed a well-defined topographical course in 24 right (80%) and 25 left (81%) preparations (Figure 2, C).

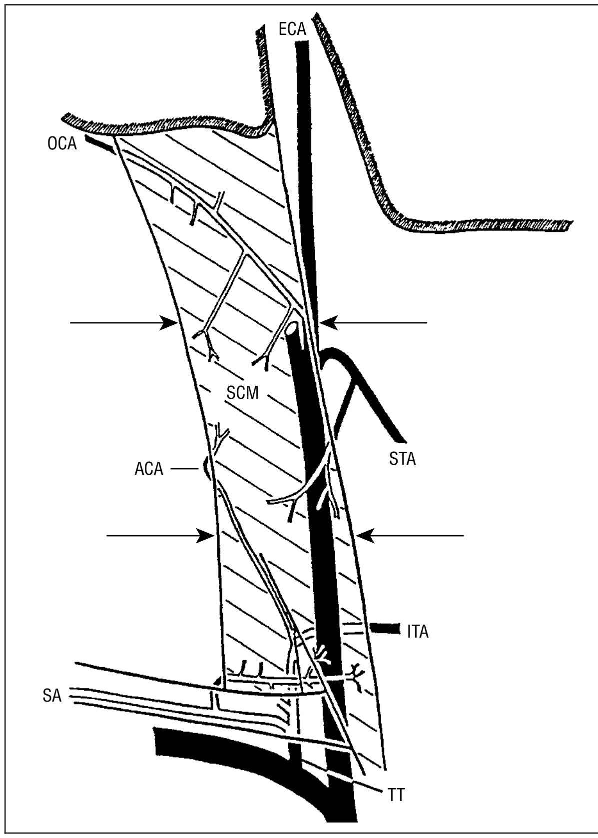

Figure 1. *Schematic illustration of all arteries supplying the sternocleidomastoid (SCM) muscle. Arrows indicate the estimated borders between the upper, middle, and lower thirds of the SCM muscle. OCA indicates occipital artery; ECA, external carotid artery; STA, superior thyroid artery; ACA, ascending cervical artery; ITA, inferior thyroid artery; SA, suprascapular artery; and TT, thyrocervical trunk.*

The caliber of this artery is comparable with those of the other main arteries that supply the SCM muscle. Under cover of the clavicle, it originates from the suprascapular artery behind the clavicular head of the SCM muscle. After ascending for about 1 cm, it bends around the lateral border of the pretracheal lamina of the cervical fascia that is attached between the omohyoid muscles. Running right between the fascia and the SCM muscle in a medial direction it supplies both heads of the muscle with several branches (**Figure 3**). One of these small muscular branches is constantly found between 2 muscular layers of the clavicular head of the SCM muscle. Furthermore, there are very tiny branches to the clavicle and to the sternum. In 2 cases, this suprascapular branch was found to take its lateromedial course superficial to the SCM muscle, being covered only by the superficial cervical fascia and the platysma.

In cases in which the branch of the suprascapular artery is remarkably thin or does not exist, either a longer branch from the superior thyroid artery descended caudally (4 cases) or a branch from the transverse or superficial cervical artery (5 cases each) supplied the lower third of the muscle.

The most important difference between the 2 types of blood supply (one arising from the suprascapular artery and the other arising from the transverse cervical artery) to the lower third of the SCM muscle seems to be their topography. The branches of the transverse or the

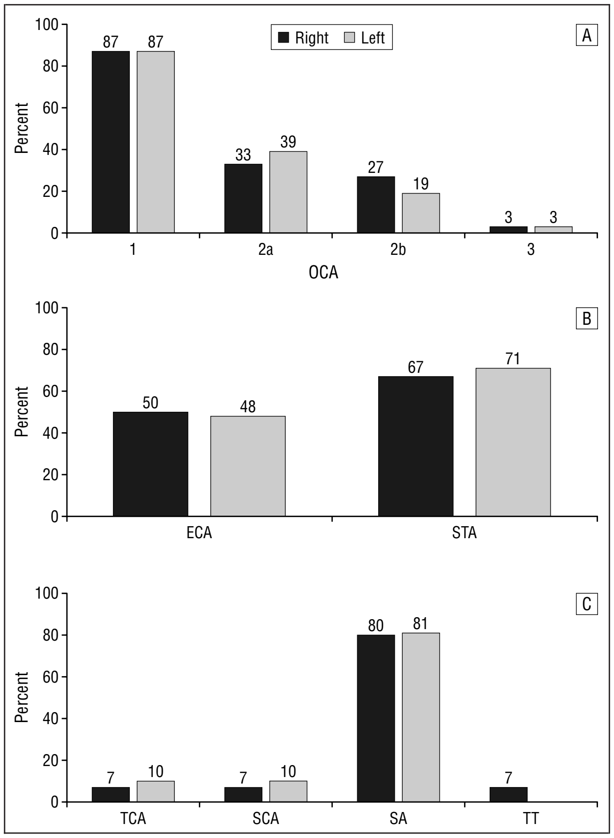

Figure 2. *Arteries supplying the sternocleidomastoid (SCM) muscle in percentage incidence of supplying vessels (n = 61). A, The upper third of the SCM muscle. 1, 2a, 2b, and 3 refer to the categorization of the branches arising from the occipital artery (OCA) given in the text. B, The middle third of the SCM muscle. ECA indicates branches arising directly from the external carotid artery; STA, branches arising from the superior thyroid artery. C, The lower third of the SCM muscle. TCA indicates branches arising from the transverse cervical artery; SCA, branches arising from the superficial cervical artery; SA, branches arising from the suprascapular artery; and TT, branches arising directly from the thyrocervical trunk. Right indicates right side of the neck; left, left side of the neck.*

superficial cervical artery have to be expected approximately 1.5 cm more cranial than that of the suprascapular artery (**Figure 4**).

In 2 cases (7%), the artery supplying the lower third of the SCM muscle arose directly from the thyrocervical trunk.

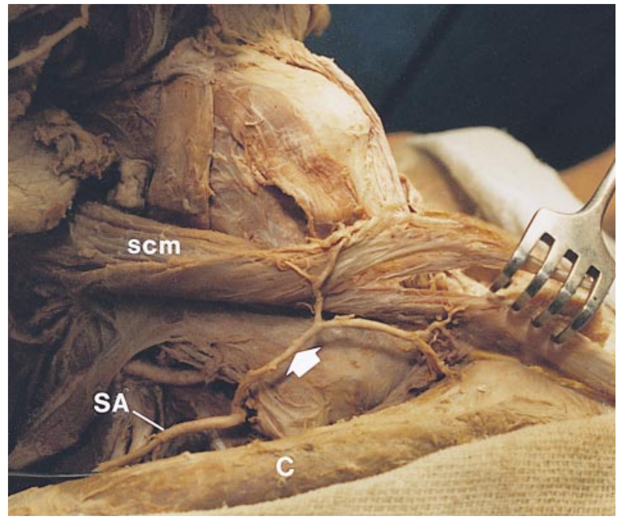

Figure 3. *Preparation of the right side of a neck. The clavicular head of the sternocleidomastoid muscle (scm) is cut and held upward. The arrow indicates the branch of the suprascapular artery (SA); C, clavicle.*

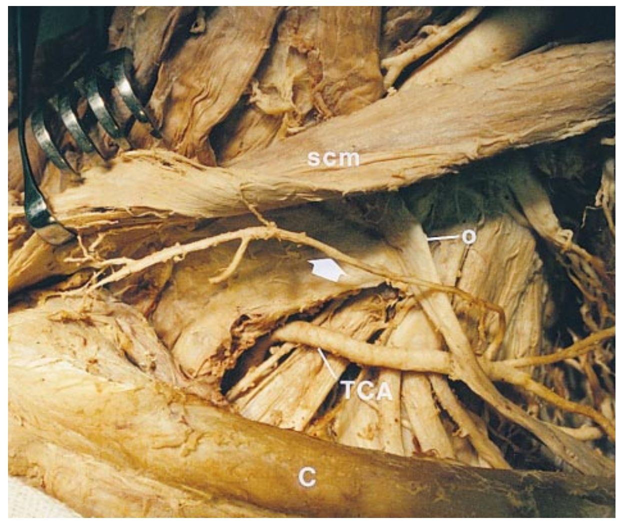

Figure 4. *Preparation of the left side of a neck. The clavicular head of the sternocleidomastoid muscle (scm) is cut and held upward. The arrow indicates the branch arising from the transverse cervical artery (TCA) bending around the omohyoid muscle (o); C, clavicle.*

COMMENT

In general, our findings are in agreement with the traditional view that the blood supply of the SCM muscle originates from 3 main arteries.[3,15,18] However, a main artery supplying the lower third of the SCM muscle has not been described up to now. Data on the variability and the frequency of the vessels under consideration could not be found in the literature. The main task of many investigations on the SCM muscle is to clarify the usefulness of the muscle as a pedicle flap.[3,10,14,16,19] Since these investigations are aimed at clinical questions, the detailed description of the SCM muscle's blood supply seems to be of secondary importance. Only a few authors have done studies using cadaver dissection to address this question.[15,16] Yet, the data presented are sometimes incomplete, possibly due to the small numbers of bodies dissected. The majority of investigators, however, cite old textbooks of anatomy.[20,21] Because the field of plastic and reconstructive surgery has advanced greatly over the past few decades, descriptions given therein may no longer be sufficient.

Agossou-Voyenne et al[17] tried to avoid these problems by investigating the blood supply of 40 SCM muscles by means of angiography. This method has at least 2 problems: first, vessels of this size may refuse filling during angiography unless a selective catheter is used, and, second, in our opinion only vessels that are already known can be reliably described from an angiogram. Therefore, this method does not seem appropriate for discovering arteries that have never been described before.

In addition, the variety of applications for the SCM muscle flap makes it nearly impossible to compare results with each other. This might be one of the reasons why there are still doubts about the reliability of the use of the SCM muscle for reconstructive procedures. Marx and McDonald,[22] for example, who used the SCM muscle as a muscular or myocutaneous flap for oral and facial reconstruction in 16 patients, described 4 cases of necrosis, representing a failure rate of 25%. Tivari[12] reported 3 failures of 9 cases, therefore raising the question whether the vascularity of the muscle is adequate for reconstruction. Furthermore, he considers the occipital artery to be the major blood supply of the SCM muscle and disagrees that splitting of the muscle could be an attractive alternative. According to our findings, we do not believe that the occipital artery is the main source of blood supply to the whole SCM muscle. Larson and Goepfert[11] also considered the occipital artery to be the major blood supply and stated that although the SCM muscle might be used to close pharyngocutaneous fistulae, it is of more limited usefulness than reported in earlier studies. Furthermore, they report on 4 failures, 3 of which had to be revised, of a total of 12 cases. Yet, in transferring the whole SCM muscle, they complained about the "bulky flap," which requires later revision. As our findings indicate and other authors already have shown, this problem can be solved by using only 1 head of the muscle (preferably the clavicular one) for transposition. Friedman et al,[7,8] who used the SCM muscle for repair of subglottic and tracheal defects, have shown that the muscle can meet requirements in selected cases. Siemssen et al,[23] who were the first to transfer only the clavicular head of the SCM muscle, reported 1 case of necrosis of 18 cases, which seems to be a very good result. Tovi,[5] following Siemssen et al's concept for the repair of laryngeal and tracheal defects, succeeded in all 3 of his cases. Alvarez et al,[24] who used a split SCM myocutaneous flap, reported 2 complete failures of 11 cases. They considered this technique (leaving the sternal head in situ) a viable alternative to other procedures. One of the most comprehensive descriptions of muscles used in plastic and reconstructive surgery of the head and neck is by Conley.[14] Although he stated that the SCM muscle has a limited and specific applicability, he does not doubt its usefulness overall.[3] A good overview about the concept and the outcome of SCM muscle transfer in various studies has been given by Yugueros and Woods.[10] They emphasize the advantages of this technique, but in contrast to our findings, state that the lower third of the muscle lacks a constant vascular anatomy.

Additionally, the sometimes inconsistent taxonomy of the vessels under consideration in the literature makes a comparison between the various surgical procedures even more difficult. For that reason we categorized the SCM branches of the occipital artery. To estimate the frequency of different types of blood supply to the SCM muscle we determined the percentage incidence of all supplying vessels. Our results indicate that only the middle third of the SCM muscle shows some variability in its blood supply. The external carotid artery and the superior thyroid artery are able to supply this part of the muscle either together or on their own. The blood supply of the lower third of the SCM muscle, however, is quite constant.

CONCLUSIONS

The demand for plastic and reconstructive surgery has been increasing quickly within the last years. The SCM muscle flap represents a considerable opportunity for reconstructions after resections within the upper aerodigestive tract. The exact knowledge of the blood supply of the SCM muscle helps to avoid muscle necrosis after transposition and will further increase the success rate of this surgical procedure. Moreover, the unique possibility of rotating either of the 2 heads of the muscle allows an aesthetic as well as functionally satisfactory result.

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REFERENCES

1. Jianu J. Die chirurgische Behandlung der Facialislähmung. *Deutsche Z Chir.* 1909; 102:377-386.
2. Owens N. Compound neck pedicle designed for the repair of massive facial defects. *Plast Reconstr Surg.* 1955;15:369-389.
3. Conley J, Gullane PJ. The sternocleidomastoid muscle flap. *Head Neck Surg.* 1980; 2:308-311.
4. Eliachar I, Moscona AR. Reconstruction of the laryngotracheal complex in children using the sternocleidomastoid myocutaneous flap. *Head Neck Surg.* 1981;4:16-21.
5. Tovi F. Sternocleidomastoid myoperiosteal flap for the repair of laryngeal and tracheal defects. *Head Neck Surg.* 1983;5:447-451.
6. Rubin JS. Sternocleidomastoid myoplasty for the repair of chronic cervical esophageal fistulae. *Laryngoscope.* 1986;96:834-836.
7. Friedman M, Toriumi DM, Strorigl T, Chilis T, Skolnik E. The sternocleidomastoid myoperiosteal flap for esophagopharyngeal reconstruction and fistula repair: clinical and experimental study. *Laryngoscope.* 1988;98:1084-1091.
8. Friedman M, Toriumi DM, Owens R, Grybauskas V. Experience with the sterno-cleido-mastoid myoperiosteal flap for reconstruction of subglottic and tracheal defects: modification of technique and long-term results. *Laryngoscope.* 1988; 98:1003-1011.
9. Casler JD, Conley J. Sternocleidomastoid muscle transfer and superficial musculoaponeurotic system plication in the prevention of Frey's syndrome. *Laryngoscope.* 1991;101:95-100.
10. Yugueros P, Woods JE. The sternocleidomastoid flap: a reappraisal. *Br J Plast Surg.* 1996;49:93-96.
11. Larson DL, Goepfert H. Limitations of the sternocleidomastoid musculocutaneous flap in head and neck cancer reconstruction. *Plast Reconstr Surg.* 1982;70:328-335.
12. Tivari R. Experiences with the sternocleidomastoid muscle and myocutaneous flaps. *J Laryngol Otol.* 1990;104:315-321.
13. Friedman M, Mayer AD. Laryngotracheal reconstruction in adults with the sterno-cleido-mastoid myoperiosteal flap. *Ann Otol Rhinol Laryngol.* 1992;101:897-908.
14. Conley JJ. *Concepts in Head and Neck Surgery.* Stuttgart, Germany: Georg Thieme Verlag; 1970.
15. Ariyan S. One-stage reconstruction of defects of the oral cavity with the sternocleidomastoid pedicle musculocutaneous flap. *Plast Reconstr Surg.* 1979;63: 618-625.
16. Jabaley ME, Heckler FR, Wallace WH, Knott LH. Sternocleidomastoid regional flaps: a new look on an old concept. *Br J Plast Surg.* 1979;32:106-113.
17. Agossou-Voyenne AK, Hureau J, Germain MA. Vascularisation et innervation du muscle sterno-cleido-mastoidien et de son revetement cutane: bases anatomiques de son utilisation en chirurgie plastique. *Ann Chir Plast Esthet.* 1991;36: 108-115.
18. Williams PL, Warwick R, Dyson M, Bannister LH. *Gray's Anatomy.* 37th ed. London, England: Churchill Livingstone; 1989:583f.
19. Glenwood AC, Hamaker RC, Singer MI. Sternocleidomastoid myocutaneous flap. *Laryngoscope.* 1987;97:970-974.
20. Spalteholz W. *Hand Atlas of Human Anatomy.* Philadelphia, Pa: JB Lippincott Co; 1921.
21. Lanz TV, Wachsmuth W. *Praktische Anatomie.* Berlin, Germany: Springer Verlag; 1955.
22. Marx RE, McDonald DK. The sternocleidomastoid muscle as a muscular or myocutaneous flap for oral and facial reconstruction. *J Oral Maxillofac Surg.* 1985; 43:155-162.
23. Siemssen SO, Kirkby B, O'Connor TPF. Immediate reconstruction of a resected segment of the lower jaw using a compound flap of clavicle and sternomastoid muscle. *Plast Reconstr Surg.* 1978;61:724-735.
24. Alvarez GE, Escamilla JT, Carranza A. The split sternocleidomastoid myocutaneous flap. *Br J Plast Surg.* 1983;36:183-186.