RADIOGRAPHIC ASPECTS AND ANGIOARCHITECTURAL ARRANGEMENTS IN CORROSION CASTS OF THE BLOOD SUPPLY TO THE HUMAN STERNOCLEIDOMASTOID MUSCLE BY THE STERNOCLEIDOMASTOID BRANCH OF THE OCCIPITAL ARTERY

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SUMMARY: The contribution of the sternocleidomastoid branch of the occipital artery (superior arterial pedicle – SAP) to the irrigation of the sternocleidomastoid muscle (SCM) was evaluated in fresh human cadavers by injecting radiological dye and a resin for microvasculature corrosion casts. From its insertion in the mastoid process of the temporal bone, the SCM was divided into superior, medium, and inferior thirds. In most of the SCM, The SAP are formed by two longitudinal parallel branches. In all specimens, the radiological dye injected into the SAP reached or trespassed the middle part of the studied SCM. The SAP was poorly distributed in the lowermost region of the inferior third of the SCM, suggesting the contribution of other arteries or pedicles. The corrosion casts of the microvasculature showed a profuse network of microscopic vessels in those levels where the SAP was detected.

DESCRIPTORS: **Sternocleidomastoid muscle. Occipital artery. Microvascularization. Scanning Electron Microscopy and " Departamento de Anatomia, Instituto de Ciências Biomédicas da Universidade de São Paulo".**

It is considered by classic anatomists that the sternocleidomastoid branch of the occipital artery is the main vessel irrigating the sternocleidomastoid muscle[9,25,28]. More recently, many authors have considered two other principal arterial branches to thsternocleidomastoid muscle as a consequence of the utilization of this muscle in plastic surgery[1,18,21,29]. According to Mathes and Nahai[17], who classified restorative muscle surgery into five categories, the sternocleidomastoid flap is considered to be of type II, and consists of a dominant pedicle with other minor vessels. Thus, the sternocleidomastoid branch of the occipital artery inhabits the upper pedicle of the muscle. The middle pedicle contains a branch of the superior thyroid artery, while the lower pedicle contains a branch of the thyreo-scapular artery.

The present work examines the involvement of the sternocleidomastoid branch of the occipital artery in irrigating all portions of the sternocleidomastoid muscle using radiography and microvascular casts analysed by scanning electron microscopy.

MATERIALS AND METHODS

Fourteen left and right sternocleidomastoid muscles (SCM) obtained from fresh adult male and female cadavers were used. The sternocleidomastoid branch of the occipital artery (superior arterial pedicle, SAP) was dissected under a surgical stereomicroscope using ophthalmological scissors and tweezers.

In 10 SCM, the radiological dye Trazograph® was injected into the SAP and the specimens simultaneously radiographed. For evaluation of the radiological dye diffusion throughout the muscle, a division of the SCM in superior, medium, and inferior thirds was considered from its insertion in the mastoid process of the temporal bone.

The SAP of a further 4 specimens were perfused with a moderate fixative solution containing 0.3% glutaraldehyde followed by blue Mercox® resin, injected using manual pressure[10]. The SCM were then immersed in 10% NaOH for 4 h at 60o C for effective resin polymerization and initiation of the corrosion

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process. Complete corrosion was obtained by keeping the SCM in 20% NaOH for three weeks at room temperature. After drying, casts of the microvasculature of the upper, medium and lower thirds of the SCM were gold sputtered in a Balzers SCD-040 device and analyzed using a Cambridge Stereoscan-240 scanning electron microscope.

RESULTS

Radiology revealed that immediately below the upper third of the SCM, longitudinal primary branches (in general two parallel longitudinal branches) of the SAP run downward to the two muscular origins. These branches emit several transverse or oblique branchlets that are poorly distributed to the inferior third of the muscle mainly in its lowermost part (Figures 1a, b). The upper third of the SCM exhibits a diffuse irrigation originating from the SAP. In some specimens, the dye is restricted to the upper half of the SCM, and in these cases, the longitudinal primary branches are absent (Figure 1c).

Seen by scanning electron microscopy, the SAP microvascular casts analyzed from the upper, middle, and lower thirds of the muscle showed a tree-like aspect (Figure 2a). The primary branches of the SAP are more superficially situated and emit two or more large branchlets that penetrate in diverse directions among the muscular fibers (Figures 2 a, b). Small branchlets arise from the large ones (Figures 2 b, c) and form a profuse network of microscopic vessels, particularly in the thicker region of the SCM (Figures 2 d-f).

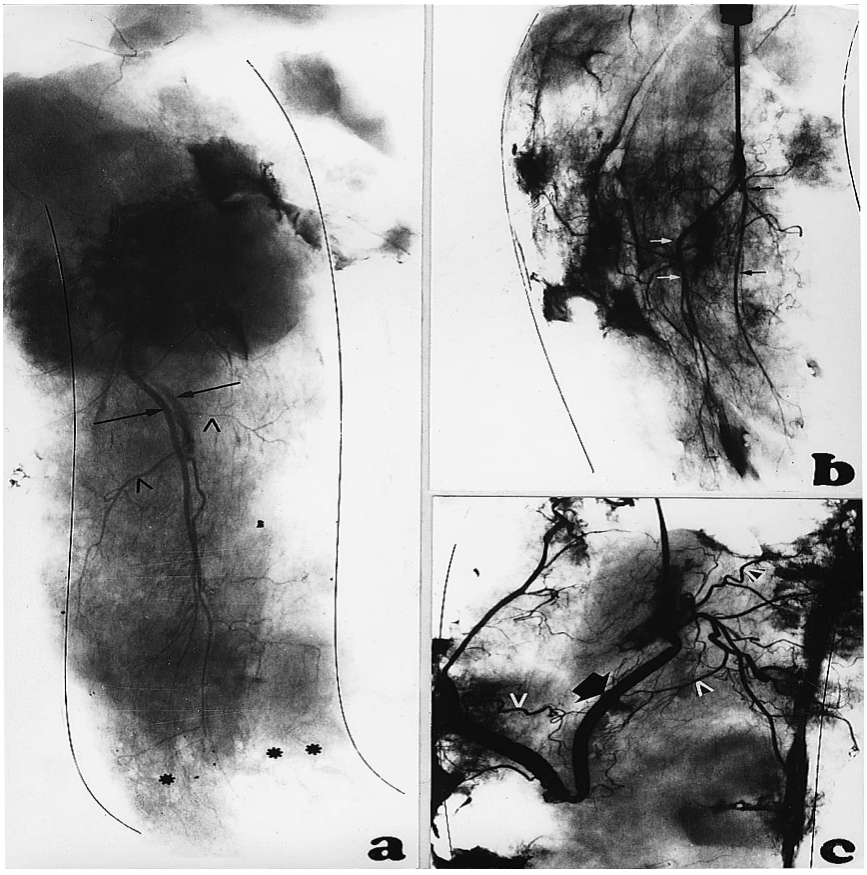

Figure 1- Radiological aspects of the SCM showing the SAP reaching different levels. a- Two longitudinal parallel branches (arrows) from which transverse or oblique branchlets (arrowheads) originate from both the sternal (*) and clavicular (**) heads of a right SCM; b- The two longitudinal, parallel branches (arrows) and their branchlets in a left SCM; c- The SAP (arrow) sends several branchlets (arrowheads) restricted to the upper half of the SCM. The two longitudinal and parallel branches of the SAP are absent.

DISCUSSION

Knowing the structure of the arterial flow leads to more reliable flap integration when compared using flaps created without knowledge of the circulatory anatomy1,[13,14,15,23]. The most significant contribution of flaps with known arteries lies in the increased likelihood of success of the surgical reconstruction[11,16,20,24,26]. Owens[21] described the versatility of sternocleidomastoid muscle rotation in cervical or pharingeal repairs and Maurer et al.[18] achieved good results in a septic sternum defect using a sternocleidomastoid flap in which the middle and the lower pedicles were preserved.

The present study of the SCM arises from its utility as a base-muscle of a myo-cutaneous flap in the cervical and facial regions[3, 4, 5, 16, 27] and its use in the partial reconstruction of organs like the esophagus, lower pharynx, and the floor of the mouth[2, 3, 8, 22].

According to some authors[16,19], the SCM is widely used but the results are not always satisfactory. An unsuccessful outcome results for about 20% of surgeries, while post-operative complications reach 30%. These problems are related to the irrigation of the SCM and are described as ischemia, partial necrosis, or fistulae[19, 27].

The SCM possesses three arterial pedicles[1, 25, 28]; the SAP was chosen for detailed analysis is because it is the main blood vessel of the SCM[17] and because of the significant rotation of the muscle when it is incised inferiorly. Though restricted to an anatomical study, the present results may contribute to success when the SCM flap is used.

Although neoprene-latex injections are performed for study the vascularization of different organs[12], the radiological and corrosion methods were important for evaluation of the distribution of the SAP branches and the three-dimensional aspects of the branchlets in the SCM tissue respec-

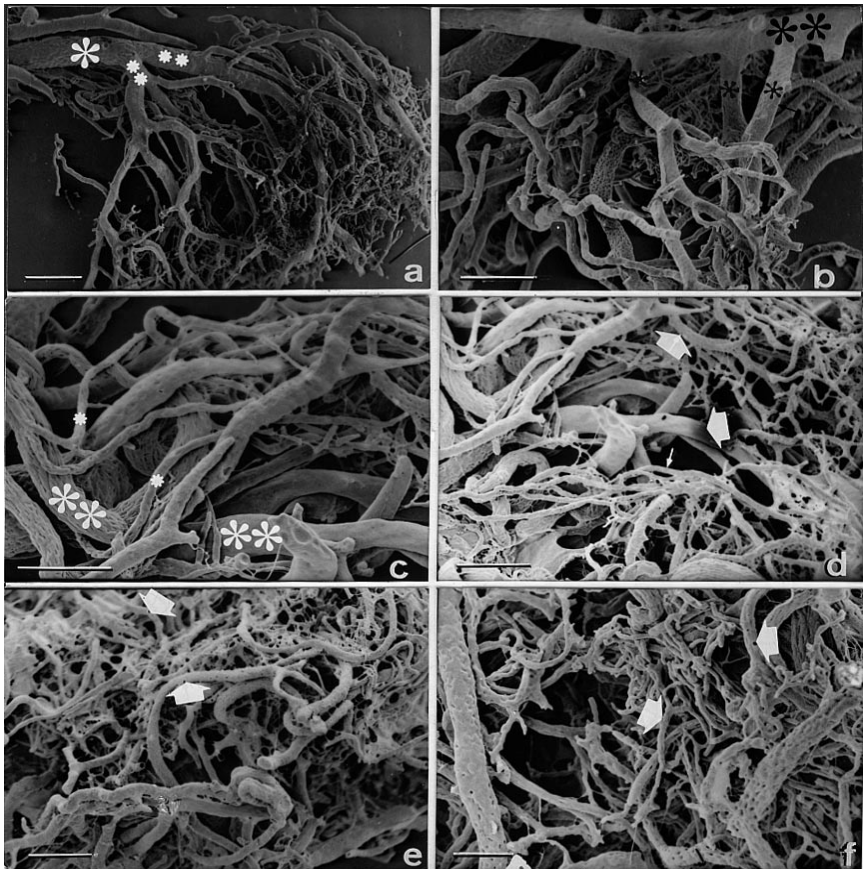

Figure 2- Corrosion casts of SAP seen by scanning electron microscopy. a- A typical, tree-like example of a branch of the SAP (*) with two large branchlets (**); b, c- Large branchlets of the SAP (**) to the upper third of the SCM with several small branchlets (*); d – f – Portions of the middle and lower thirds of the SCM showing a profuse network of vessels of diverse diameters (arrows). (scale bars: a- 500 mm; b, d, e- 250 mm; c- 200 mm; f- 100 mm)

tively. The corrosion injection allows direct visualization of the branches immersed in the muscle, which is not necessarily the case when bi-dimensional radiographic aspects of the SCM are examined[6].

In the present study, the uppermost branch of the occipital artery situated upper the SAP was not observed[1], and our results effectively demonstrate the SAP distribution, since a branch of the accessory nerve was also present in all SCM. This finding corroborates De Souza's[7] affirmation that the nerves and vessels penetrate a relatively constant topographic region of the muscle, and that of Agossou-Voyeme et al.[1] who reported this arterial branch in all specimens studied. Thus, while some factors may have contributed to eventual failures in the techniques employed (like the consistency of the SCM, or pressure of the injections performed), in those cases where irrigation was restricted to the upper levels of the SCM, most probably the lowest pedicles were the main vessels of the SCM. Even so, the contribution of the SAP is significant, as it reaches and trespasses the middle part of the muscle.

Considering that in any specimen studied, the SAP territory was more than half the muscle length, all SCM flaps with a maximal length corresponding to the half of the muscle have their irrigation guaranteed by this pedicle. Flaps that exceed this limit, reaching five-sixths of the SCM length are much less likely to be successful. This fact suggests that the role of other lower pedicles should be carefully considered in the irrigation of the SCM as described by authors as Mathes and Nahail[16], that consider this muscle as presenting a dominant vascular pedicle plus minor pedicles.

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RESUMO

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FRÓES, L. B. et al. – Aspectos radiográficos e da microvasculatura do músculo esternocleidomastóideo pelo pelo ramo da artéria occipital. **Rev. Hosp. Clín Fac. Med. S. Paulo 54(4):** 127 - 130, 1999.

A contribuição do ramo esternocleidomastóideo da artéria occipital para a irrigação do músculo esternocleidomastóideo foi avaliada em cadáveres humanos não fixados, através da injeção de contraste radiográfico e de resina polimerizável para estudo da microvasculatura. O músculo foi dividido nos terços superior, médio e inferior, a partir da sua inserção no processo mastóideo do osso temporal. Na maioria dos músculos, o pedículo superior apresentou-se formado por dois ramos paralelos longitudinais. Em todos os casos, o contraste radiográfico atingiu ou ultrapassou a parte média do músculo. Na parte mais distal do terço inferior, há pouca ou nenhuma contribuição do pedículo superior para a irrigação dessa região muscular sugerindo a contribuição de outros vasos para a sua irrigação. Os modelos de corrosão demonstraram a presença de uma profusa rede vascular no interior do músculo.

DESCRITORES: **Músculo esternocleidomastóideo. Artéria occipital. Microvascularização. Microscopia eletrônica de varredura.**

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