Anatomical Science International (2021) 96:478–480
https://doi.org/10.1007/s12565-020-00592-6

CASE REPORT

Temporalis muscle vasculature directly derived of the middle meningeal artery: a case report and review

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Received: 22 June 2020 / Accepted: 3 December 2020 / Published online: 12 February 2021

Abstract
Pedicled temporalis muscular flap is a common procedure nowadays in reconstructive head and neck surgery, especially for oral or orbital cavity defects. We present a case of temporalis muscle and skull base dissection of a seventy-year-old fresh female cadaver with single temporal muscle vessels directly derived of the middle meningeal artery throughout the calvaria, therefore jeopardizing the harvest of the flap, which has never been described to our knowledge. Such a variation must be known of the reconstructive surgeon to plan the ideal reconstruction procedure.

Keywords Temporalis muscle · Muscular pedicled flap · Anatomical variation · Middle meningeal artery · Temporal fossa

Dear Editor-in-Chief,

We would like to document the case of a temporalis fossa dissection of a seventy-year-old fresh female cadaver with single deep temporal vessels directly derived of a middle meningeal artery (MMA) branch emerging throughout the calvaria. The temporal region can provide for the reconstructive surgeon many different flaps towards head and neck oncologic or global reconstructive surgery. Besides the superficialis temporalis fascia flap (STF) that can be used as a free or a pedicled flap for various losses of tissue, the muscular temporalis flap gets extensive description in the literature. Its main indications are the reconstruction of oral cavity defects (palatal arch or posterior pharyngeal wall loss of tissue), orbital defects (as the cover of an orbital exenteration), or for facial nerve reanimation surgery techniques. Its harvesting easiness and the reliability of a large muscular area, with a rich vasculature and neglectable sequalae make it an essential weapon in the reconstructive surgeon's arsenal. Its anatomical vasculature is very well described: directly derived of the external carotid artery system (ECS), throughout the maxillary artery (MAI), the deep temporal vessels (DTV) (veins and artery) run deep to the temporalis muscle over the periosteum and divide themselves in two main branches for the temporal muscle (Elazab and Abdel-Hameed 2006; Nakajima 1995). The MMA, also derived from the MAI and ECS normally supplies the dura mater and is often described to give small accessory branches to the temporalis muscle. Anatomical work took place inside the School of Surgery "Ecole de Chirurgie du Fer à Moulin", based in Paris, 7 rue des Fossés Saint Marcel, 75005, Paris, Ile-de-France. The subject had given his prior written assessment to donate its body for anatomic experiments. We performed a temporalis region dissection of a seventy-year-old female fresh cadaver at the second post-mortem day. Surgical approach consisted of a classic cutaneous "T incision" exposing the temporalis region within the "follicles pilei" surgical plan (Fig. 1a). After exposure of the STF with special care brought to the TSA and frontal branch of the facial nerve, the STF incision allowed to expose the superficial layer of the deep temporalis fascia within the middle temporal fossa. The temporalis muscle was then harvested with the superficial and deep layers of the deep temporalis fascia by a circumferential incision until the calvarial bone is reached and then a sub-periosteal elevation (Fig. 1b). In a normal dissection, the identification and exposure above the zygomatic arch of the DTA with both anterior and posterior branches is usually performed, but in this precise case, we were unable to identify any independent deep temporalis vessels. As a matter of fact, the vasculature of the temporalis muscle was entirely insured by the anterior branch of the

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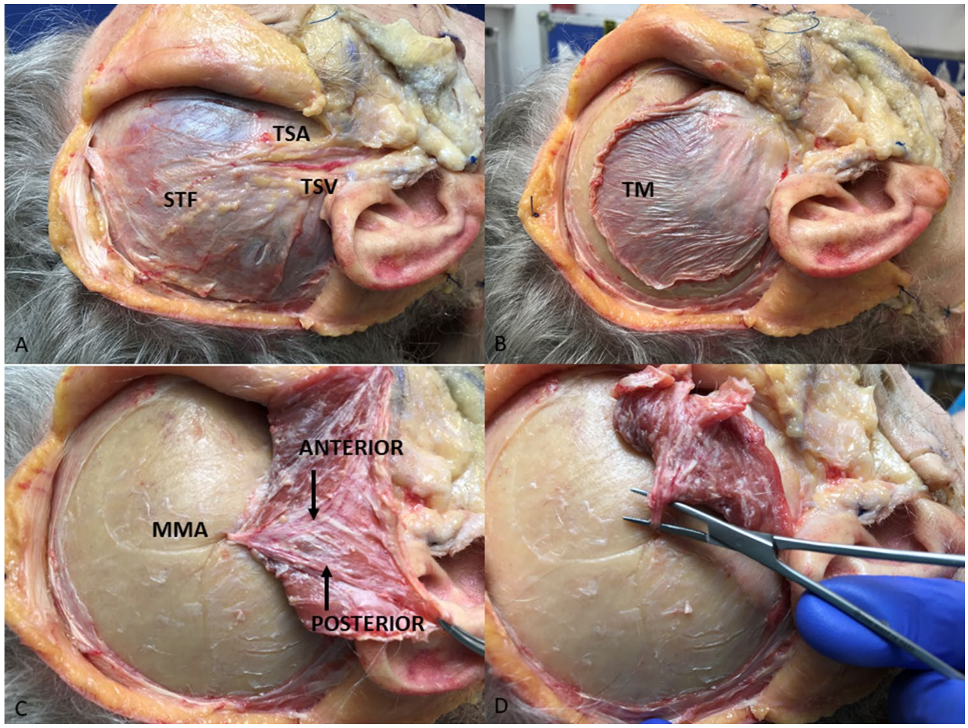

Fig. 1 **a** Superficial Temporalis Fascia exposure with Temporal Superficial Artery and Vein. **b** Temporalis muscle exposure **c** Temporalis muscle harvest with anterior and posterior branches of the Deep Temporal Vessels. **d** Trans-calvarial branch of the Middle Meningeal Artery supplying the Deep Temporal Vessels

MMA, which gave a perforator throughout the calvaria, which divided itself in two (anterior and posterior) branches at the deep layer of the muscle, therefore jeopardizing the harvest of the flap (Fig. 1c, d). Further dissection of the infra-temporal and pterygo-palatine fossae after zygomatic, mandibular osteotomy and removal of the temporal bone after burr hole trepanation confirmed the intracranial continuity with the MMA, but showed no other deep temporal vessels arising from the MAI, with similar diameter and the contralateral side after dissection and exposure showed no such anatomical variations of the deep temporal vessels, with a standard temporal fossa dissection and the usually described anatomical landmarks. Also, the trans-calvarial passage was very close to the usually described location of the sphenoidal fontanel and parietal sutures, and had the anatomical characteristics of a bony foramen, with outer table cortical bone all along the calvarial width. Furthermore, the middle meningeal artery has usual anatomical course except for this bony perforator (4–5 cm above the zygomatic arch), arising from the foramen spinosum inside the skull base, located at the greater wing of the sphenoid bone, and then continued its path superficially to the dura mater. Many anatomical studies have described the vasculature of the temporal muscle: this area is richly supplied by the ECS, through the MAI and the collateral and anastomotic networks of the STA, with various variations described. Nevertheless, none have referred to the description of DTV rising from an MMA branch. From and embryological point of view, according to Padget (1948) (Padget 1948), the development of both MMA and MAI is very complex: the MMA derives from the stapedial artery (1st pharyngeal arch) while the MAI derives from the maxillo-mandibular trunk (2nd pharyngeal arch) during the 2nd stage of the development of both vertebrobasilar and carotid artery systems (6 mm crown-rump length). A connection between the third and the second arch allows the main ECS to encompass the maxillo-mandibular trunk and therefore the maxillary artery, but no embryological connections between the first and the second arch are described. Furthermore, the temporal fossa vasculature also relies on the development of the temporalis muscle, which relies itself on the trigeminal nerve development, derived from the first pharyngeal arch, while the cranial vault derives from the chondrocranium. From a surgical and clinical point of view, many studies described the temporal fossa and cranial vault vasculature, but none of them report such an anatomical variation. Cutting (1984) published an arterial injection study with dissection of the temporal region of 10 subjects with the aim of clarifying the calvarial vasculature to describe and codify surgical procedures for the reconstruction of calvarial losses of substance, based on regional flaps.(Cutting 1994) An anatomical study by Elazab (2006) including 44 specimens has describe a classic vasculature of the muscle based mainly on the DTA of the MAI and the MTA from the TSA. It also described in all anatomical subjects an anastomotic network between the temporal branches of the MMA and the DTA (Elazab and Abdel-Hameed 2006). Finally, he reported the presence of direct branches of the MAI, and in 10% of cases, a third satellite vascular pedicle (forming an anterior, posterior and middle branch). Another anatomical study published by Nakajima (1995) has reported for the vasculature of the temporal muscle six supplying vessels for the muscle: the TSA and MTA derived from the ECS, the anterior and posterior DTA and the MMA derived from the MA (Nakajima 1995). However, MMA anatomical variations are not so rare, as a study by Uchino (2017) has described bilateral carotid-anterior cerebral artery anastomoses associated with bilateral ophthalmic arteries arising from the middle meningeal arteries (Uchino 2017). Nevertheless, it can be easily supported and explained by the multiples embryological studies on the subject. As a matter of fact, the ophthalmic artery branches from the internal carotid artery extension and resolves in anastomosis between the external and internal carotid artery system at this level, and the previous work published by Adachi (1928) and Kodama et al. (Sato T ed, book, 2000) suggested that anatomical variations could occur in this area (Sato and Akita 2000; Adachi 1928). Also, the MMA had the same diameter than the MAI (approximately 5 mm), which supports the fact that the middle meningeal artery was probably the main supplying artery for the DTA and MTA. In this description is reported the classic vascular anatomy of the MMA, and the only trans-calvarial vessels described are micro-perforators anastomoses to the deep temporal network, with no individualized arterial supply for the temporalis muscle. In this specific matter, we were unable to retrieve out of the literature the description of a deep vascular pedicle directly derived of the MAI. Furthermore, after further dissection, we were unable to identify the MTA vessels, and the tunnel observed on the temporal bone clearly corresponded to the path of the anterior branch of the DTA rising of the MMA. Yet, this anatomical variation has direct practical consequences. To reach the rotation point above the zygomatic arch to allow optimal positioning of the flap, this anastomosis must be cut, which compromises its vascularization, and the whole surgery; also, given the major involvement of the MMA in extradural hematomas of traumatic origin and its flow, its hemostasis should be perfect and this anastomosis should be clipped or ligated between vascular sutures. To conclude, temporalis muscular pedicled flaps may be supplied by a unique MMA branch throughout the calvarial bone, which jeopardizes the harvest of the flap. This anatomical exception must be known, and further studies should try to specify its frequency, even if very rare.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12565-020-00592-6.

Acknowledgements We gratefully thank the *School of Surgery in Paris: "Ecole de Chirurgie du Fer à Moulin", based in 7 rue des Fossés Saint-Marcel, 75013, Paris, Ile de France, FRANCE, AGEPS, AP-HP*, its headmaster Pr. Pascal Frileux, its scientific director Mr. Djamel Taleb, and all the staff as they kindly supported all our experiments inside the school.

Author contributions GR: main author, corresponding author, performed all anatomical work, figures and wrote the manuscript. LG: last author, helped in a major contribution, suggested the anatomical work, and helped in overall writing and corrections of this article.

Funding The authors have no conflict of interest in any financial issues to declare.

Data availability All data and material have been provided to reviewers and Editorial Board.

Compliance with ethical standards

Conflict of interest None.

Ethical approval The local ethical committee gave full written approval to perform this study.

Consent to participate The patient had given prior consent for the use of the body of medical research and anatomical work, and full written consent to publish and resulting data.

Consent for publication The authors affirm that human research participants provided informed consent for publication of the images in Fig. 1a–d.

References

Adachi B (1928) Das Arteriensystem der Japaner. Band I Maruzen Kyoto

Cutting CB et al (1994) Blood supply of the upper craniofacial skeleton: the search for composite calvarial bone flaps. Plast Reconstr Surg 74:603–610

Elazab EEB, Abdel-Hameed FAM (2006) The arterial supply of the temporalis muscle. Surg Radiol Anat 28:241–247

Nakajima H et al (1995) The arterial anatomy of the temporal region and the vascular basis of various temporal flaps. Br J Plast Surg 48:439–450

Padget DH (1948) The development of the cranial arteries in the human embryo. Contribution to embryology. Carnegie Institution 32:205–261

Sato T, Akita K (eds) (2000) Anatomic variations in Japanese. University of Tokyo Press, Tokyo

Uchino A et al (2017) Bilateral carotid-anterior cerebral artery anastomoses associated with bilateral ophthalmic arteries arising from the middle meningeal arteries diagnosed by magnetic resonance angiography: a case report. Surg Radiol Anat 11:1289–1292