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ORIGINAL ARTICLE

Description of the Pedicled Osteo-Muscular Flap of Split Temporal Muscle

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Abstract

Background Reconstruction of the head and neck is dominated by free flaps, and for bone reconstruction by fibula and scapula flaps. However, this choice is sometimes difficult to make in patients who cannot tolerate an extensive and lengthy surgical procedure. In addition, vascular micro-anastomoses are sometimes complicated in patients who have been previously irradiated. Pedicle flaps remain an option and can sometimes be considered as first choice for head and neck reconstruction.

Purpose In this study, we describe the feasibility of a split temporal muscle pedicled flap with coronal harvesting for a reconstruction that can reach the midline.

Study design, sample, covariates Ten fresh-frozen human cadaver heads were dissected, and the length of the split flap was noted, followed by the length of the non-split flap.

Results The mean length was 155.7 mm (± 20.0) for the split flap, from the point of rotation to the tip of the coronoid process. These results coincide with the tragus-midline distance, which makes it possible to consider reconstruction of the midline, especially the maxilla and the mandible, which has not yet been described in the literature.

Conclusions and relevance This technique would then allow a supply of pedicled vascularized bone for locoregional reconstruction.

Keywords Pedicle flap · Bone reconstruction · Head and neck

Introduction

Facial bone reconstruction using free flaps (fibula, scapula, iliac crest) is now common practice in the field of oncology and traumatology [1]. But free flaps have disadvantages and the cost of this choice is not to be neglected. First of all, performing a free flap requires an experienced surgical and anesthetic team [2]. Pedicled flaps allow a reduction in operating time and length of stay in intensive care unit [3]. The realization of a free flap is sometimes complicated in case of previous cervicofacial radiotherapy, by local vascular modifications with a higher rate of bad wound healing and fistulization as described by Sun et al. [4]. Reconstruction with free flaps then becomes difficult, either because cervicofacial dissection is difficult, or because the anastomoses are compromised by vascular desert; free flaps may even require additional venous bypass surgery [5].

Patients operated with a free flap often need additional interventions [4], for haematoma, scar disunion, and for flap plasties because often the cutaneous and subcutaneous area of a donor area is not of the same volume as the cutaneous and subcutaneous area of the recipient area [6]. Free flaps require on average five times more emergency reoperations than pedicled flaps [4]. In addition, skin sensitivity is usually not preserved on the free flap palette, unlike with pedicled flaps [3]. Some authors have demonstrated the value of a sensitive flap to improve functional recovery [7]. Sometimes there is significant donor site morbidity [8], with scarring that is sometimes significant, particularly in the case of fibular harvesting.

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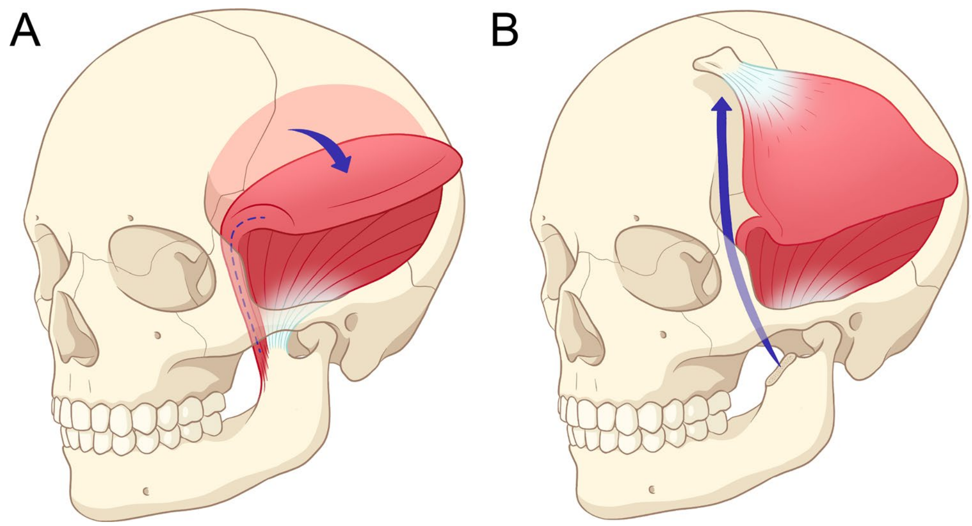

Fig. 1 Scheme of the surgical procedure **A**. Muscle is removed from the temporal fossa. **B**. The muscle is separated in its thickness at the tendinous insertion lamina. The superficial and deep layers of the muscle remain connected by the upper quarter of the muscle. A coronoid process endo-buccal osteotomy is performed to be transposed into the temporal fossa

The realization of a pedicled flap is then a good alternative and is as described by some authors sometimes a first-choice option for head and neck reconstruction [9]. There are fewer options for bone reconstruction with pedicled flaps. The temporal flap can be used, in combination with a calvarial graft as described by Kilinc and Aytekin [10], or with a coronoid process harvest. Other less commonly used options are the pedicled medial scapular crest flap [11], and the supraclavicular flap in combination with a half-thickness clavicular harvest as described by Johnson et al. [12].

The temporal flap associated with the coronoid process has been described by some authors in the form of case reports, for reconstruction of the orbital floor after maxillectomy [13–17], or for reconstructions of the skull base [18]. The coronoid process is a structure particularly suited to facial bone reconstruction, especially for the orbital floor [19].

Veyssiere et al. [20] have described increasing the length of the temporal muscle flap alone, by dividing the superficial and deep layers of the muscle. In fact, there is a tendinous insertion lamina within the muscle from the coronoid process to the upper quarter of the muscle, separating a deep layer, vascularized by the deep anterior and posterior temporal arteries (from the internal maxillary artery) and a superficial layer, vascularized by the superficial temporal artery. In the upper quarter of the muscle, the two arterial systems anastomose. It is thus possible to separate the two layers, ligate the deep temporal vessels and obtain a split temporal muscle vascularized by the superficial temporal artery alone.

We will study here, through a study on anatomical subjects, the feasibility of a bone reconstruction on the median line, i.e., the orbital walls, and the nasal pyramid, thanks to the splitting of this temporal muscle.

Material and Methods

Subjects

We dissected 10 fresh-frozen human cadaver heads for this study who had signed their consent during their lifetime for body donation for educational and medical research purposes in accordance with the guidelines of the French Bioethics law. No inclusion or exclusion criteria were defined. All cadavers were injected with red-stained silicon.

Dissection Technique

A coronal incision extended to the pretragal area is made in a supine subject with a 15 blade. The dissection is started in the subcutaneous plane above the superficial temporal fascia. This fascia will not be detached from the temporal muscle and its aponeurosis because it will guarantee its vascularization via the superficial temporal pedicle.

The superficial temporal fascia and deep temporal fascia are incised at the upper edge of the muscle, and the muscle is removed from the temporal fossa with a stripper up to the deep temporal pedicles which will be ligated (Fig. 1).

An endobuccal incision is made opposite the homolateral coronoid process, which will be roughened on both sides up to the sigmoid notch. The coronoidectomy is then performed with an osteotome or a saw. The coronoid process attached to the temporal muscle is then transposed into the temporal fossa.

Separation of the two layers of the temporalis muscle is achieved by incising the muscle on its deep side, in contact with the coronoid process, down to the tendinous insertion lamina which is preserved. The splitting of the muscle is then performed, preserving this fibrous lamina, up to its upper limit.

Table 1 Description of the subjects

N (%)		
N		10
Gender		
	Male	4/10 (40%)
	Female	6/10 (60%)
Age		81.5 ± 14.2
Side		
	Right	6/10 (60%)
	Left	4/10 (40%)
Temporal height		
	Mean ± SD	79.6 ± 10.8
	Median	77.5
	Min	63.0
	Max	99.0
Temporal width		
	Mean ± SD	95.1 ± 12.8
	Median	95.0
	Min	72.0
	Max	115.0
Distance tragus—midline		
	Mean ± SD	164.8 ± 5.4
	Median	164.0
	Min	157.0
	Max	173.0

SD standard deviation

Measurements and Statistics

The height of the temporalis muscle, corresponding to the distance from the zygomatic arch to the superior temporal line was recorded, as well as the greatest width of the muscle.

The length (i.e., between the zygomatic arch and the tip of the coronoid process) of the undivided flap, was noted, followed by the length of the divided flap. The length of the tendinous insertion lamina and the greatest width of the coronoid process were also recorded.

Finally, the distance from the tragus to the midline of the face was noted.

The results were compared by non-parametric Wilcoxon tests with *R*.

Results

Ten anatomical subjects were included in the study. The mean age was 81.5 (± 14.2) years. There were 6 women (60%) and 4 men (40%), 6 right temporal muscles (60%), 4 left temporal muscles (40%).

The temporal height, i.e., from the temporal arch to the superior temporal crest, was on average 79.6 mm (± 10.8). The temporal width averaged 95.1 mm (± 12.8). The distance from the tragus to the midline averaged 164.8 mm (± 5.4). These results are detailed in Table 1.

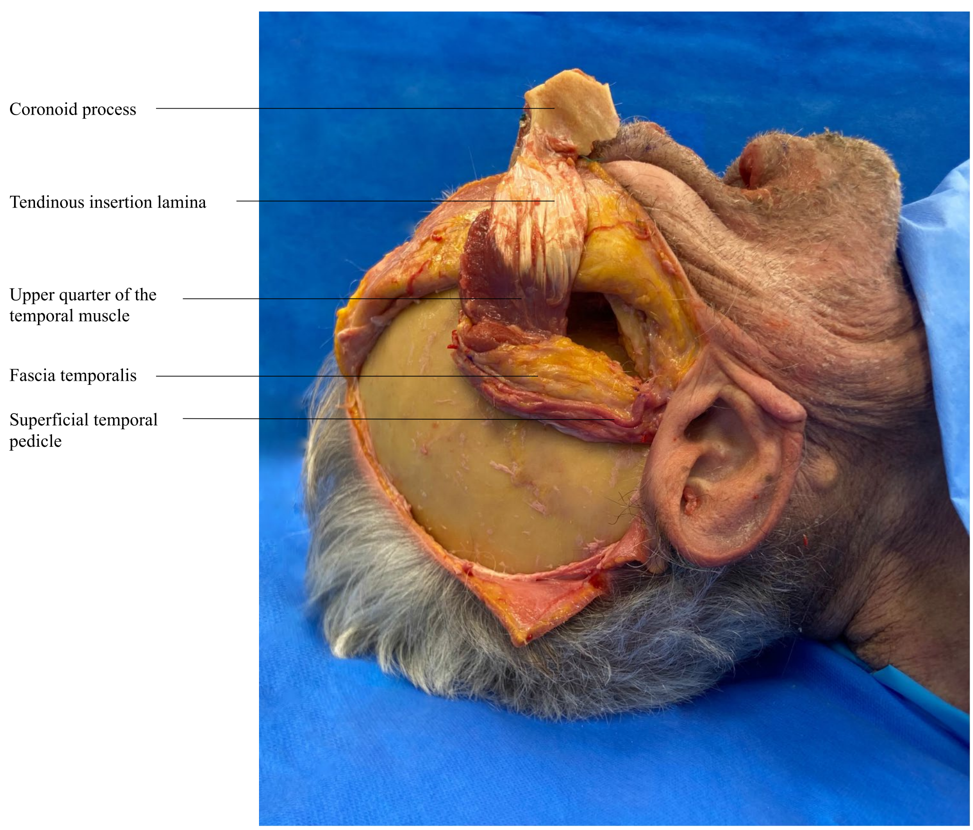

Fig. 2 Dissection of the split temporal muscle osteo-muscular flap in a fresh cadaver after injection of the vessels

Table 2 Description of the flaps

N (%)		
Non-split flap length		
	Mean ± SD	97.7 ± 15.8
	Median	96.5
	Min	75.0
	Max	132.0
Split flap length		
	Mean ± SD	155.7 ± 20.0
	Median	148.5
	Min	134.0
	Max	192.0
Increase in flap length		
	Mean ± SD	58.0 ± 12.6
	Median	55.5
	Min	43.0
	Max	87.0
Tendinous insertion lamina length		
	Mean ± SD	59.2 ± 7.6
	Median	61.0
	Min	46.0
	Max	71.0
Coronoid process width		
	Mean ± SD	24.8 ± 3.9
	Median	23.0
	Min	21.0
	Max	32.0

SD standard deviation

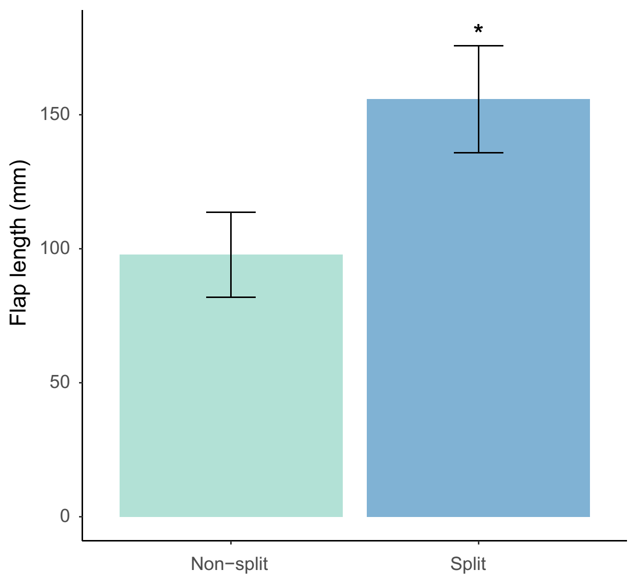

Fig. 3 Barplot representing the mean lengths between the unsplit and split osteo-muscular flaps, with their confidence intervals. The difference was significant ($p < 0.001$)

The length of the untrimmed flap averaged 97.7 mm (± 15.8) compared to 155.7 mm (± 20.0) for the trimmed flap, from the point of rotation to the tip of the coronoid process. This difference was statistically significant ($p < 0.001$, Fig. 2). The gain in flap length after splitting was on average 58 mm (± 12.6). The average tendinous insertion lamina was 59.2 mm (± 7.6). The average width of the coronoid process was 24.8 mm (± 3.9), with a minimum of 21 mm and a maximum of 32 mm (Table 2).

Discussion

This dissection technique adapted from Veyssiere et al. [11] allows for a pedicled coronal transfer for bone reconstruction. In our dissections, the average flap length was 155.7 mm (± 20), ranging from 134 to 192 mm in one subject. These results coincide with the tragus-midline distance, which makes it possible to consider reconstruction of the midline, especially the maxilla and the mandible, which has not yet been described in the literature. This technique could also be adapted to the reconstruction of the orbital cavity, with the temporalis muscle allowing the filling and the coronoid process one of the orbital walls. The coronoid process is a particularly suitable structure for the reconstruction of the orbital floor [19]. One team even describes the possibility of mandibular ramus harvesting extending the coronoid process for larger bone defects.

The gain in flap length (on average 58.0 mm ± 7.6) coincided with the length of the tendinous insertion lamina (on average 59.2 mm ± 7.6). The junction between the superficial and deep layers is provided by the upper quarter of the temporal muscle (Fig. 3).

Facial bone vascularization has been described in a paper by Gharb et al. [21], which shows that the coronoid process is mainly nourished by its periosteum. Thus, the superficial temporal artery vascularizes the superficial layer of the temporal muscle, and then via the upper quarter of the muscle the deep layer, and thus allows the vascularization of the coronoid process by the periosteum, despite the ligation of the deep temporal vessels, as shown by Veyssiere et al. [20] and Chen et al. [22].

Free flaps are not always the best solution for head and neck reconstruction [4]. Pedicled flaps allow for a less cumbersome, shorter surgical procedure that is better suited to fragile patients [2], with often less re-interventions afterward [4]. Vascularization is often safer, especially after locoregional irradiation, and does not require venous bypass surgery as in the most complex cases.

Takushima et al. [23] et Van Gemert et al. [24] reports a failure rate of slightly more than 7% on free bone flap series. A study conducted by Zhou et al. [25] shows that this failure rate can reach 14% in case of prior irradiation. This necrosis rate is estimated at 1.6% by Spanio di Spilimbergo et al. [26] on a series of 366 pedicled temporal flaps. We can consider this method of bone reconstruction as a first choice in fragile patients who cannot undergo microsurgery or in patients with a high risk of free flap failure. This technique could make it possible to add muscle, to fill a loss of tissue substance or cover a bone exposure; and bone, to reconstruct a defect. But it needs to be applied to patients to determine the potential complications and the long-term evolution of muscle and bone volumes.

Conclusion

This technique would then allow a supply of pedicled vascularized bone for loco-regional reconstruction. Pedicled flaps can be of precious help and are sometimes first-line choices in patients who are sometimes multi-operated, fragile, and irradiated, for whom vascular micro-anastomoses can be complicated to perform.

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Declarations

Conflict of interest The author declares there is no conflict of interest.

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