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CASE SERIES

Proximal facial artery loop mobilization to increase pedicle length and flap reach in submental flap reconstruction: a prospective case series

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ABSTRACT

Objective: To evaluate whether mobilization of the proximal facial artery loops increases pedicle length and flap reach during submental flap reconstruction of orofacial defects.

Methods: This prospective case series was conducted at Rehman Medical Institute, Peshawar, Pakistan, from 2024 to 2025. Seven patients undergoing submental flap reconstruction for orofacial defects located >7 cm from the flap harvest site were included. Two pedicle-lengthening techniques were evaluated: mobilization of the mandibular loop by ligating the distal facial artery and mobilization of the pharyngeal loop through submandibular gland mobilization. Pedicle length gained by each maneuver and postoperative outcomes were recorded. Patients were followed for at least one year.

Results: The mean age was 47.5 years (range: 20–74 years); four patients were male and three were female. Defect sizes ranged from 4×4 cm to 8×8 cm. Pharyngeal loop mobilization was performed in all seven patients, increasing flap reach by a mean of 1.5 cm (range: 1.2–1.8 cm). Mandibular loop mobilization was required in three patients and provided an additional mean pedicle length gain of 1.0 cm (range: 0.9–1.1 cm). Partial donor-site necrosis occurred in five patients, one required rhomboid flap reconstruction, and one developed transient House-Brackmann grade II marginal mandibular nerve weakness. No locoregional recurrence was observed during follow-up.

Conclusion: Mobilization of the proximal facial artery loops effectively increases pedicle length and flap reach, extending the reconstructive versatility of the submental flap for selected orofacial defects while maintaining acceptable morbidity.

Keywords: Surgical Flaps (MeSH); Submental flap (Non-MeSH); Reconstructive Surgical Procedures (MeSH); Facial Artery (MeSH); Neck (MeSH); Mouth (MeSH); Oral Surgical Procedures (MeSH); Prospective Studies (MeSH); Anatomic Variation (MeSH); Dissection (MeSH).

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INTRODUCTION

Reconstruction of orofacial defects remains a major surgical challenge, requiring restoration of both function and aesthetics through replacement of like tissue with like. Although free tissue transfer remains the gold standard for reconstruction of complex defects, pedicled flaps continue to play an important role because of their technical simplicity, shorter operative time, and lower resource requirements. The submental flap (SMF), first described by Martin D, et al., in 1993, has emerged as a reliable alternative for selected orofacial defects.[1] Since its introduction, SMF has gained widespread acceptance; in a survey of 212 American head and neck surgeons, 51% reported using the flap, with 43% experiencing few complications.[2]

The outcomes of the submental flap have been extensively compared with those of free tissue transfer in terms of aesthetic appearance, functional recovery, and oncological safety. Meta-analyses have demonstrated that SMF provides functional, aesthetic, and oncological outcomes comparable to free tissue transfer while significantly reducing operative time and hospital stay.[3,4] Despite these advantages, the limited length of the submental vascular pedicle often restricts flap mobility and reach, particularly for distant defects.[5-7] Various modifications have been proposed to overcome this limitation. The present study describes two simple techniques based on mobilization of the proximal facial artery loops to increase pedicle length and extend the reach of the submental flap.

Applied Anatomy

Proximal Facial artery: The facial artery originates as a separate branch from the external carotid artery about 1 to 3.5 cm from bifurcation. It advances forward deep to posterior belly of digastric and stylohyoid muscle reaching the posterior margin of the submandibular gland. Here it forms pharyngeal loop on the surface of lateral pharyngeal wall giving off ascending pharyngeal branch. Running in upward direction along the posterior margin of submandibular gland, facial artery curves along the curvature of submandibular gland. Here 3 to 4 glandular vessels come off from the main artery supplying the sub-mandibular gland along with an inconsistent tributary to the platysma. After reaching the superomedial surface of the gland, it makes another loop around the curvature of the lower border of mandible. Here it gives off the submental branch close to the medial surface of the mandible before appearing on the face. The facial artery

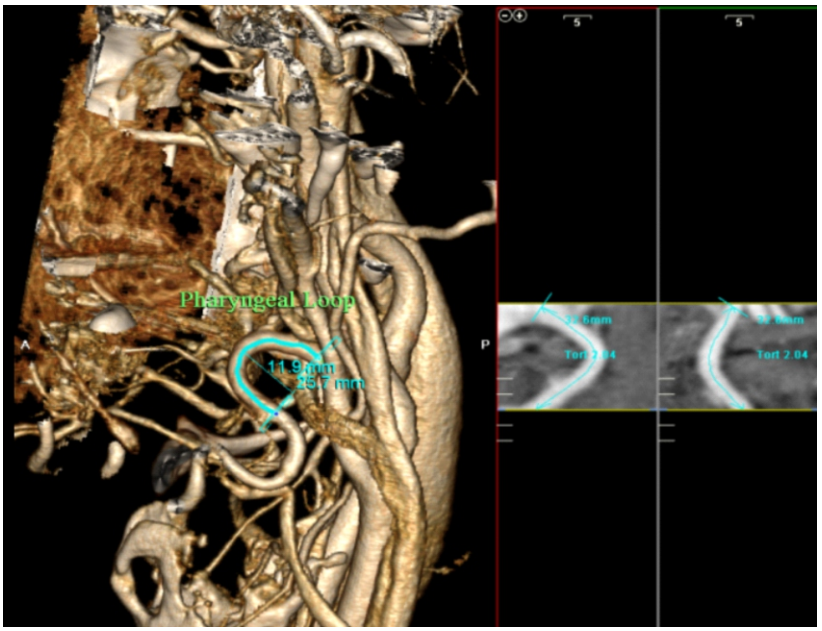

Figure 1: Proximal facial artery loops

advances further on the face in upward and medial direction terminating as angular vessel (Figure 1).[5]

Submental artery: The submental artery is a consistent branch of the facial artery which originates on the lateral surface of submandibular gland just before its appearance at the lower border of the mandible. It has generally a length of 6-7 cm with an average diameter of 1-3 mm.[5,6] It runs over the lateral surface of the mylohyoid muscle close to its attachment to the mylohyoid ridge. In most cases, it ends deep to the anterior belly of digastric (ABD) by forming terminal vessels.[8] There are generally 1 to 2 perforators that supply the skin. These perforators are usually found on the lateral border of the anterior belly of digastric. The submental vein usually accompanies SMA and has a diameter of 1.6 to 2.9 mm. It usually drains into facial vein with an inconsistent communicating vessel to external jugular vein.[7]

METHODS

This comparative cross-sectional study For this study, the proximal facial artery was defined as the segment extending from its origin to the origin of the submental artery, while the distal facial artery was defined as the segment distal to the origin of the submental artery.

It was hypothesized that straightening the mandibular and pharyngeal loops of the proximal facial artery would increase pedicle length and improve flap reach. This prospective single-center, single-surgeon case series was conducted on patients undergoing submental flap reconstruction for orofacial defects. Ethical approval was obtained from the Research Ethics Committee of Rehman Medical Institute, Peshawar, Pakistan (Reference No. RMI/RMI-REC/Article Approval/59; dated: May 25, 2021), and written informed consent was obtained from all participants. Seven patients were enrolled between 2024 and 2025 and were followed for at least one year postoperatively.

Inclusion criterion: Since the length of submental artery is 6-7 cm as reported in literature,[8] we decided that any patient in whom the proximal end of the defect was farther than 7 cm from the harvest site could be potentially included in the study.

Exclusion criterion: Any patient in which the proximal end of the defect was less than 7 cm away from the harvest site was excluded from the study. Distance was measured from the distal end of the defect to the distal end of the flap using surgical plastic ruler.

Surgical technique: Defect size was measured antero-posteriorly as well as medio-laterally (Figure 2) utilizing surgical measuring plastic ruler. The skin paddle was harvested as per standard technique originally described by Martin D et al.[1] Incision was given 1-1.5 cm below the lower border of the mandible to preserve the marginal mandibular nerve (Figure 3). Dissection was carried out in subplatysmal plane from medial to lateral direction and ipsilateral ABD was harvested in all cases to preserve the submental artery and its skin perforators. The submental artery was identified on the medial side of the ABD and preserved. It was then dissected posteriorly along with a sleeve of mylohyoid muscle to prevent any damage to the vessel (Figure 4 & 5). Once it was confirmed clinically that flap pedicle will need lengthening in order to reach defect site, lengthening procedures are performed (distal end of the defect > 7 cm away from the distal end of the flap). There were two lengthening procedures used, mobilization of the mandibular loop and the mobilization of the pharyngeal loop of the proximal facial artery.

1. Mobilization of Mandibular loop

In order to mobilize the mandibular loop, the facial artery distal to the origin of submental vessel was ligated. Proximal facial artery was then separated gently from the mandible in subperiosteal plane and mandibular loop straightened. Potential risk includes damage to the marginal mandibular nerve.

2. Mobilization of pharyngeal loop

Submandibular gland was mobilized while preserving facial artery that is closely adhered to its posterior and superior surfaces. Glandular vessels are preserved in all cases along with submandibular duct. Branches to platysma and styloglossus muscle, if encountered, were ligated. Potential risk included damage to proximal facial artery itself.

Measurement of pedicle length

Pedicle length was measured at three points.[13,14] First, the base line was measured by measuring the distance from the point of origin of submental artery to the proximal end of skin

Figure 2: Defect after removing squamous cell buccal carcinoma.

Figure 3: Incision markings for submental flap

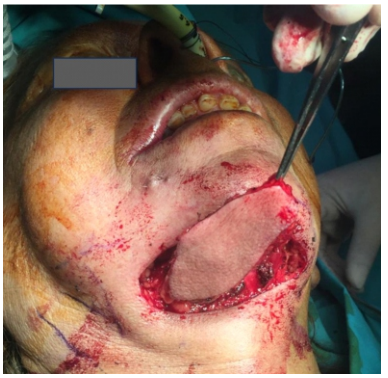

Figure 4: Submental flap elevated

Figure 5: Defect closed with submental flap

paddle. Second, mandibular loop was mobilized and extra length achieved was measured. Third, pharyngeal loop was mobilized and length again was again measured.

(The tip of mandibular loop convexity was taken as the point of origin of submental artery)

RESULTS

Overall, 7 cases were included in this study. The pathologies for which resections were performed are given in Table 1. Age range varied from 20-74 years (mean age: 47.5 years). There were 4 male subjects and 3 females. Shortest size defect reconstructed was 4×4 cm and the largest was 8×8 cm. Corresponding flap harvested were generally kept slightly smaller than the defect size. Anterior belly of digastric (ABD) was harvested in all cases.

Maximum extent to which skin paddle was shifted to the contralateral side was 5.5 cm. Mandibular loop lengthening was performed in 3 cases with average 1 cm gain in pedicle length. Pharyngeal loop lengthening was performed in all 7 cases with average gain of up to 1.5 cm in flap reach (Table 1).

Overall, 5 cases developed partial necrosis at the harvest site and needed repair without any flap and 1 needed rhomboidal flap. In 1 case, grade 2 marginal mandibular weakness was also observed that resolved over a period of 6 weeks. There was no case of locoregional recurrence of disease in the first year post surgery (Table 1).

DISCUSSION

While submental flap is an excellent option for reconstructing oral cavity defect, one of its major draw backs is its short pedicle length. In this case series we have shown that up to 2.0 to 2.5 cm length can be gained by employing the two surgical techniques described above. While not huge in size, even such limited increase in length can make all the difference since oral cavity is in close proximity of submental region.

In their original description of the submental flap, Martin D et al. reported that a skin paddle measuring up to 7 × 18 cm, including tissue extending across the midline to the contralateral side, could be safely harvested.[1] The vascularity of this flap is provided by one to four perforators, typically located around the anterior belly of the digastric muscle, which supply the contralateral skin through the subdermal plexus.[7,9] In the present case series, we successfully harvested skin paddles extending up to

Table 1: Clinico-pathological characteristics of the study participants

Pathology	Amelob-lastoma	Gun shot	BCC Face	SCC tongue	SCC buccal mucosa	MEC buccal	Electric burn to face
Age (years)	36	20	45	74	70	48	40
Size defect (cm)	6×3	6×6	8×8	5.5×3.5	4×5	4×4	7.5×2
Flap size (cm)	6.5×3	4×4.5	6×3	5×3	3×5	2.5×6	7×2
SMG Mob. (length gain)	Yes (1.5 cm)	Yes (1.3 cm)	Yes (1.7 cm)	Yes (1.5 cm)	Yes (1.2 cm)	Yes (1.5 cm)	Yes (1.8 cm)
FA ligation (length gain)	Yes (1.1cm)	Yes (0.9 cm)	Yes (1.0 cm)	No	No	No	No
Morbidity	PN	PN	PN	Rhomboid flap	MM (HB 2)	Nil	PN

SMF: submental flap; FTT: free tissue transfer; ABD: Anterior belly of digastric muscle; SMA: Submental Artery; SMV: Submental Vein; SCC: squamous cell carcinoma; MEC: mucoepidermoid carcinoma; BCC: basal cell carcinoma; SMG Mob: submandibular gland mobilization; FA: facial artery; TIP MOV: tip movement; REC: recurrence; MM: marginal mandibular; PN: partial necrosis; Mand: mandible

5.5 cm across the contralateral side without compromising flap viability.

Distal facial artery ligation to increase submental flap pedicle length was first described by Sterne GD et al. in 1996.[10] Subsequently, Multinu A, et al., reported that this technique could provide up to 2 cm of additional pedicle length, although they noted that the accompanying vein might become taut.[11] In the present series, distal facial artery ligation was performed in three patients, resulting in an average pedicle length gain of approximately 1 cm without compromising flap viability.

Pedicle length can be further potentially gained through straightening of pharyngeal loop with or without ligation of the distal facial artery. We found that additional 1.5 cm length can be gained further using this maneuver. This mobilizing is be performed safely by mobilizing the submandibular gland while preserving the facial artery on its posterior and the superior surface. This technique was performed in all 7 patients without ligating the submandibular duct or glandular vessels.

Several techniques have been described to increase the reach of the submental flap pedicle, including the Y-V venous lengthening procedure, reverse-flow flap, hybrid flap, and division of the posterior belly of the digastric muscle.[12] The Y-V procedure involves ligating the facial vein, mobilizing it from the internal jugular vein, and preserving its communication with the external jugular vein for venous drainage, providing up to 5 cm of additional pedicle length.[11-14] In the hybrid technique, the facial vein is divided and re-anastomosed to another recipient vein, thereby overcoming the limitation imposed by venous pedicle length.[15,16]

Reverse flow flap has been reported by more than one surgeon where facial artery proximal to submental vessel is ligated hence raising the flap on distal artery. Since facial vein has no valves, venous drainage is directed through angular vein.[10] Division of posterior belly of digastric is the other technique through which further 1 cm length can be gained.[9]

CONCLUSION

Mobilization of the mandibular and pharyngeal loops of the proximal facial artery provides an additional 2.0–2.5 cm of pedicle length, extending the reach and reconstructive versatility of the submental flap for selected orofacial defects. The technique appears safe, without compromising flap perfusion or causing significant additional morbidity.

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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

ZD: Conception and study design, drafting the manuscript, approval of the final version to be published

MG: Conception and study design, acquisition, analysis and interpretation of data, drafting the manuscript, critical review, approval of the final version to be published

KZN: Acquisition, analysis and interpretation of data, critical review, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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