

Platysma Motor Nerve Transfer for Restoring Marginal Mandibular Nerve Function

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Background: Injuries of the marginal mandibular nerve (MMN) of the facial nerve result in paralysis of the lower lip muscle depressors and an asymmetrical smile. Nerve reconstruction, when possible, is the method of choice; however, in cases of long nerve gaps or delayed nerve reconstruction, conventional nerve repairs may be difficult to perform or may provide suboptimal outcomes. Herein, we investigate the anatomical technical feasibility of transfer of the platysma motor nerve (PMN) to the MMN for restoration of lower lip function, and we present a clinical case where this nerve transfer was successfully performed.

Methods: Ten adult fresh cadavers were dissected. Measurements included the number of MMN and PMN branches, the maximal length of dissection of the PMN from the parotid, and the distance from the anterior border of the parotid to the facial artery. The PMN reach for direct coaptation to the MMN at the level of the crossing with the facial artery was assessed. We performed histomorphometric analysis of the MMN and PMN branches.

Results: The anatomy of the MMN and PMN was consistent in all dissections, with an average number of subbranches of 1.5 for the MMN and 1.2 for the PMN. The average maximal length of dissection of the PMN was 46.5 mm, and in every case, tension-free coaptation with the MMN was possible. Histomorphometric analysis demonstrated that the MMN contained an average of 3,866 myelinated fiber counts per millimeter, and the PMN contained 5,025. After a 3-year follow-up of the clinical case, complete recovery of MMN function was observed, without the need of central relearning and without functional or aesthetic impairment resulting from denervation of the platysma muscle.

Conclusions: PMN to MMN transfer is an anatomically feasible procedure for reconstruction of isolated MMN injuries. In our patient, by direct nerve coaptation, a faster and full recovery of lower lip muscle depressors was achieved without the need of central relearning because of the synergistic functions of the PMN and MMN functions and minimal donor-site morbidity. (*Plast Reconstr Surg Glob Open* 2016;4:e1164; doi: 10.1097/GOX.0000000000001164; Published online 13 December 2016.)

Injuries of the marginal mandibular nerve (MMN) of the facial nerve result in paralysis of the lower lip muscle depressors and an asymmetrical smile.¹ The most common causes

of paralysis of the MMN are iatrogenic injuries of the nerve during operations in the submandibular or parotid regions.²

Nerve repair when possible is the reconstructive method of choice because it provides restitution of the natural force vectors by the lower lip muscle depressors and the mentalis muscle; however, in the presence of long nerve gaps or delayed nerve injuries, conventional nerve repairs may be difficult to perform or may provide suboptimal outcomes. In late cases, treatment options for isolated MMN palsies include botulinum toxin chemodenervation, mioneurectomies, and/ or muscle transfers.³

The aim of this study is to investigate the anatomical technical feasibility of the nerve transfer of the platysma motor branch of the MMN for restoration of lower lip function in isolated MMN injuries. Furthermore, we present a clinical case to illustrate this nerve transfer.

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METHODS

Anatomic and Histomorphometric Study

Nineteen hemifaces were dissected in 10 adult cadavers at the Center of Anatomy, Medical University of Vienna, Vienna, Austria. The dissections were performed by 3 plastic surgeons. The faces were dissected through a preauricular face-lift incision at a sub-superficial muscular aponeurotic system plane level. The MMN and platysma motor nerve (PMN) branches were identified in every specimen. Measurements included the number of MMN and PMN branches, the maximal length of dissection of the PMN from the anterior border of the parotid, and the distance from the anterior border of the parotid to the

facial artery (Fig. 1). The PMN reach for direct coaptation to the MMN at the level of the crossing over the facial artery was assessed in every hemiface.

After anatomical measurements were made, the PMN and the MMN were divided and excised at the level at which they would be coapted in a nerve transfer procedure, and nerve samples from the distal ends of both nerves were taken for the histomorphometric study. Nerve biopsy specimens of the PMN and MMN were immersed immediately in a 2.5% solution of glutaraldehyde buffered with cacodylate, postfixed with 2% osmium tetroxide, and embedded in epoxy resin. Semithin sections were obtained using an ultramicrotome (Ultracut E; Reichert Jung, Nuloch, Germany), stained with 1% *p*-phenylenedi-

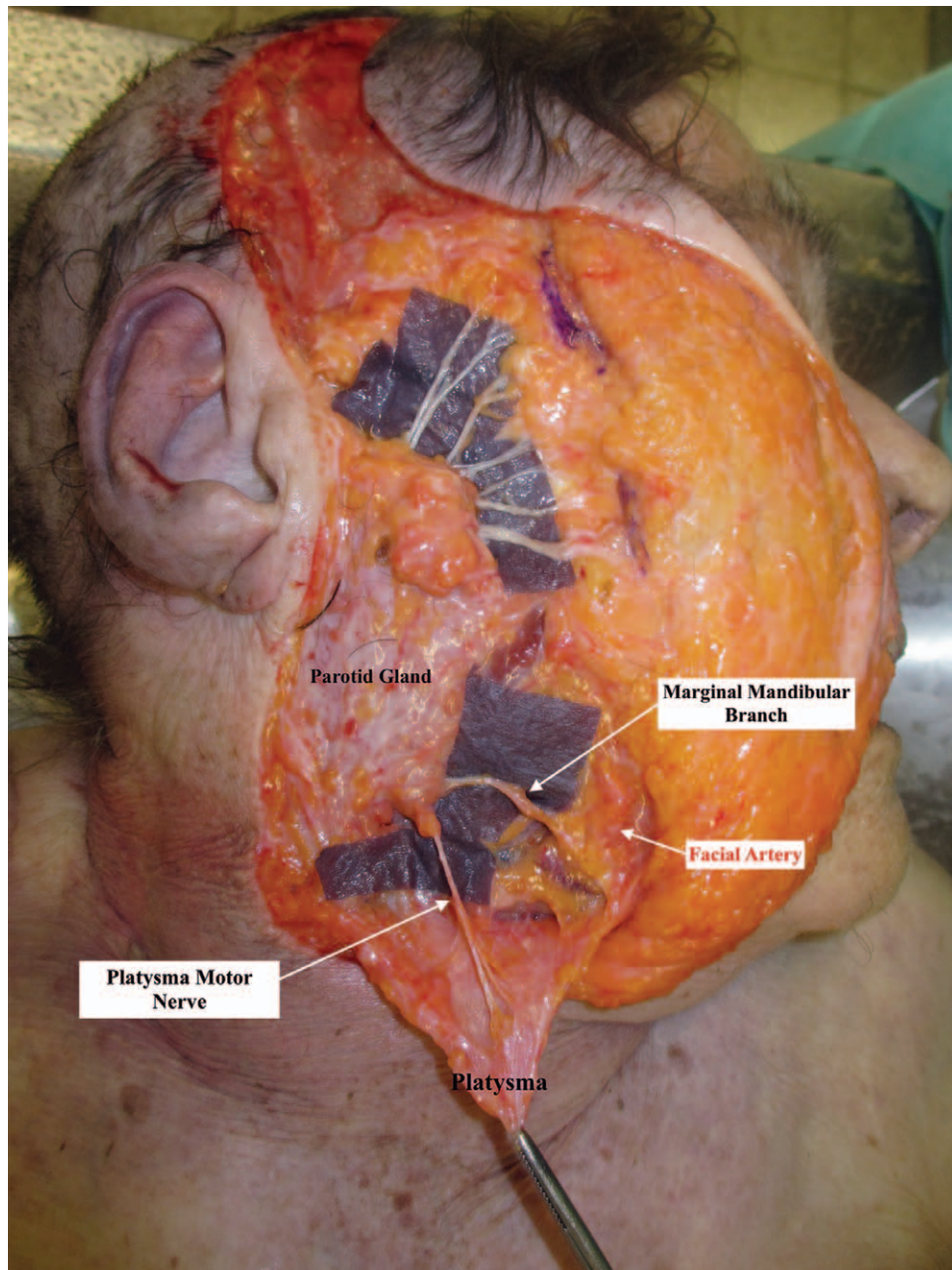


Fig. 1. Cadaver dissection of the branches of the right facial nerve after retraction of the facial skin flap.

amine (Sigma Chemical Co., St. Louis, Mo.) in absolute alcohol, and examined under light microscopy (Axiomat; Zeiss, Oberkochen, Germany) as previously published.⁴

Myelinated axons were counted from a representative area of the nerve and presented as fiber counts per square millimeter. Measurements were performed with a pen linked to a personal computer using a semiautomatic image analyzing system (LUCIA-M; Nikon Laboratory Imaging, Prague, Czech Republic). Gross morphometric measurements were obtained at 100× magnification, and detailed measurements were obtained at 500× magnification. A single individual uniformly performed all nerve processing, staining, and axon counting. Descriptive statistics were used. Means are reported with their corresponding SDs.

RESULTS

The location of the MMN and PMN was consistent in all dissections, with an average number of subbranches of 1.5 ± 0.8 for the MMN and 1.2 ± 0.4 for the PMN. The average maximal length of dissection of the PMN from the anterior border of the parotid gland to it started branching inside the platysma was 46.5 ± 13.4 mm. The average distance of the MMN from the anterior border of the parotid gland to the crossing over the facial artery was 30.7 ± 7.9 mm, and in every case, tension-free coaptation with the MMN was possible at the level of crossing with the facial artery. Histo-morphometric analysis demonstrated that the MMN contained an average of $3,866 \pm 1,434$ myelinated fiber counts per millimeter, and the PMN contained $5,025 \pm 2,352.3$.

CASE REPORT

A 66-year-old man presented with a soft tissue sarcoma in the left jaw angle, requiring a tumor resection that included the skin over the mandible, the parotid gland, part of the masseter muscle, and sacrifice of the MMN. Nerve reconstruction was performed with a nerve transfer of the PMN to the MMN (Fig. 2), and soft tissue reconstruction was performed with a free anterolateral thigh flap anastomosed to the facial vessels (Fig. 3). The postoperative course was uneventful, and the patient sustained temporary paralysis in the left lower lip muscle depressors (Fig. 4). After 3 years, the patient is free of tumor recurrence and has a complete recovery of MMN function (Fig. 5) without the need of central relearning and without functional or aesthetic impairment resulting from denervation of the platysma muscle (Fig. 6).

DISCUSSION

The MMN is one of the branches of the facial nerve more vulnerable to injury in surgical procedures around the submandibular region, such as neck dissection, parotidectomy, and rhytidectomy or in surgical approaches to the mandible.^{1,2,5}

The MMN is particularly vulnerable to injuries if the surgical dissection is performed around the facial vessels.⁶⁻⁸ Furthermore, the lack of intrabranched connections of the MMN with other facial nerve branches makes less likely a spontaneous recovery of lower lip muscle depressor function in the event of an MMN injury. The PMN or the cervical branch of the facial nerve arises from the lower division of the facial nerve, and because its course is

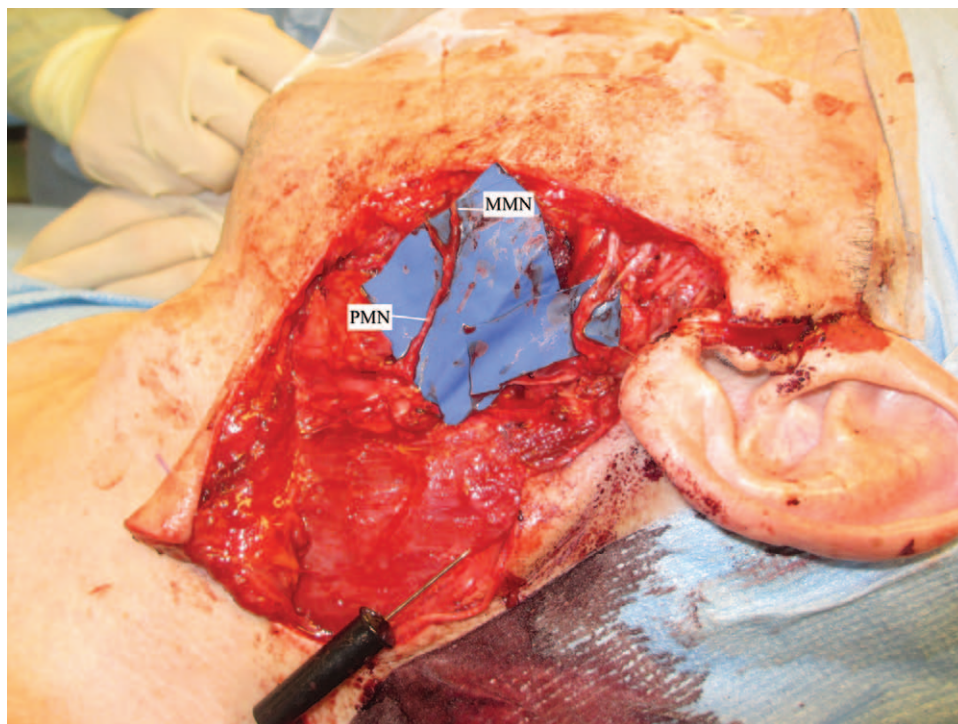


Fig. 2. Intraoperative photograph of the clinical case showing the nerve transfer of the PMN to the MMN.



Fig. 3. Image of the anterolateral thigh flap used for soft tissue coverage at the end of the operation.



Fig. 4. Immediate postoperative photograph of the patient showing paralysis of the left lower lip muscle depressors.

more posterior and deeper than the MMN, it is less vulnerable to injury.⁹

The MMN and PMN have synergistic functions as both innervate muscles providing unhappy mimic expressions, as the lower lip muscle depressors and the platysma, are activated vertically from cranial to caudal. The presence of lip eversion provided by the mentalis muscle reveals that the MMN is intact, making the differential diagnosis between isolated MMN or PMN injuries as described by Daane et al¹⁰ who describe the presence of MMN pseudo-

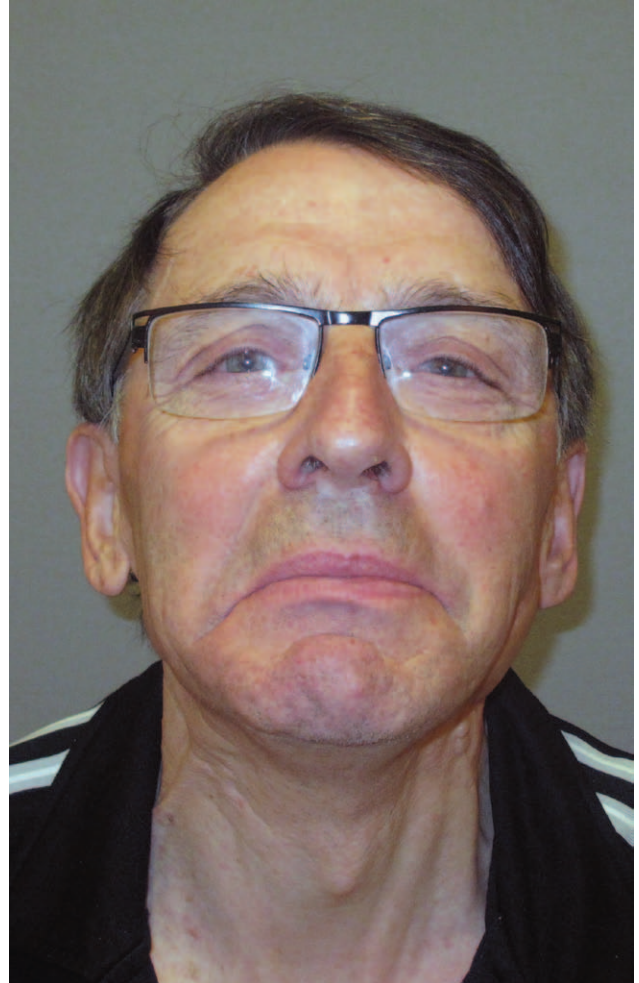


Fig. 5. Follow-up 3 years postoperative showing complete recovery of the lower lip muscle depressors.

paralysis from injuries to the platysma motor branch in 1.7% of face-lift procedures.

When injury to the MMN is detected intraoperatively, the best result is obtained when direct nerve repair or grafting is performed immediately; however, if the injury is not detected and the nerve is unrepaired, leaving the presence of long nerve gaps, or if the region is explored in a delayed fashion, having a proper nerve coaptation without tension or identifying both stumps from the nerve can pose a challenge. In that regard, PMN transfer can provide a large source of axons from a nerve that is close to the MMN and has a synergistic effect. The PMN is easy to identify as it courses under the platysma from the anterior-inferior part of the parotid gland and provides the possibility of performing direct nerve repair without sacrificing a donor site for nerve grafting. The injury of the PMN is less likely to occur in comparison to MMN in procedures such as rhytidectomy because of its location and depth. In our study, we observed that the nerve can be dissected a long distance before it branches within the platysma, allowing for direct coaptation to the distal stump of the MMN in every case at the crossing with the



Fig. 6. Follow-up 3 years postoperative of the patient showing no donor-site morbidity after platysma denervation.

facial artery in the anatomical study and in the clinical case that we present. Qin-kai Zhai et al¹¹ recently reported a clinical series of 26 patients with injuries of the facial nerve reconstructed using this concept of intrafacial nerve transfers where unimportant branches of the facial nerve (upper buccal or cervical branches) were transferred to more important branches (zygomatic or MMN); 11 MMN injuries were reconstructed by PMN transfer in that article with reported excellent or good outcomes. In the clinical case we present, where we performed PMN transfer to the MMN, we observed no clinically relevant donor-site morbidity after denervating the platysma muscle (as it can be seen in Fig. 5). This is coherent with the reported literature of cases where the PMN was injured¹¹ or used intentionally as a donor nerve in nerve transfers for reconstruction of brachial plexus injuries¹² or isolated injuries to the spinal accessory nerve¹³ where no donor-site complications were observed related to denervation of the platysma muscle.

In conclusion, PMN to MMN transfer is an anatomically feasible procedure for reconstruction of isolated

MMN injuries. In our patient, by direct nerve coaptation, a faster and fuller recovery of lower lip muscle depressors and the mentalis muscle was achieved without the need of central relearning because of the synergistic functions of the PMN and MMN functions and minimal donor-site morbidity being in this case a valid alternative to conventional nerve grafts.

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PATIENT CONSENT

The patient provided written consent for the use of his image.

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