

CASE REPORT

Nagoya J. Med. Sci. **82**. 123–128, 2020
doi:10.18999/nagjms.82.1.123

Repair of temporal branch of the facial nerve with novel polyglycolic acid-collagen tube: a case report of two cases

Yutaka Nakamura, Keisuke Takanari, Katsumi Ebisawa, Miki Kanbe,
Ryota Nakamura and Yuzuru Kamei

*Department of Plastic and Reconstructive Surgery, Nagoya University Graduate School of Medicine,
Nagoya, Japan*

ABSTRACT

Autologous nerve transplantation has been the gold standard in the treatment of facial nerve injury, however it has not been achieved satisfactory result and needs donor sacrifice. A polyglycolic acid collagen conduit (Nerbridge, Toyobo Co., Japan) has the potential to compare to or exceed autologous nerve grafts in promoting nerve regeneration. Here we report two cases of traumatic temporal facial nerve injury repairs with Nerbridge. The severed temporal branch of the facial nerve was repaired with Nerbridge conduits in two patients. Recovery of movement was assessed by clinical photography and needle electromyography. The frontal muscle started moving five months postoperatively in both cases. Electromyography at twelve months showed polymorphic electric discharge, suggesting connection of the injured nerve to the frontal muscle. In the final results, each patient had good eyebrow elevation distance and moderate forward gaze recovery in comparison to their healthy sides. Considering that facial nerves are reported to recover incompletely even in autologous nerve graft repair cases, our two cases showed reasonable recovery comparable to nerve autografting. The Nerbridge conduit is a promising alternative to standard treatments for facial nerve recovery.

Keywords: artificial nerve, facial nerve injury, nerve defect, nerve regeneration, polyglycolic acid-collagen conduit

Abbreviations:

HB: House-Brackmann Score

MRD: Margin reflex distance

This is an Open Access article distributed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License. To view the details of this license, please visit (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

INTRODUCTION

Facial paralysis is not a life-threatening disease, but the associated functional, cosmetic, psychological, and social disorders are significant problems. Ideal treatment outcomes are recovery of muscle tone and symmetry at rest as well as voluntary facial movement without synkinesis.

Received: November 30, 2018; accepted: May 20, 2019

Corresponding Author: Yutaka Nakamura, MD

Department of Plastic and Reconstructive Surgery, Nagoya University Graduate School of Medicine, 65
Tsurumai-cho, Showa-ku, Nagoya 466-8560, Japan

Tel: +81-52-744-2525, Fax: +81-52-744-2527, E-mail: nkmr@med.nagoya-u.ac.jp

Table 1 Outcome of facial nerve reconstruction with autologous nerve graft.

study	year	Case count	Duration of facial palsy (mean) (month)	Meaningful outcome of postoperative facial function (\leq HB grade III) (%)
Arriaga and Brackmann. ¹	1992	8	3–13 (7.4)	13
Samii and Matthies. ²	1997	42	1–95 (18.3)	73
Falcioni et al. ³	2003	56	1–120 (20.2)	46
Gunther et al. ⁴	2010	21	0.5–29 (5.4)	86
Ozmen et al. ⁵	2011	155	1–600 (25.4)	68

Subsequent to interruption of the facial nerve, the best functional nerve recovery reported to date is House-Brackmann (HB) Grade III (Table 1).^{1–5} Autologous nerve grafting is considered to be the best choice for repair of nerve gaps, however numbness and scarring at the donor site are disadvantages. In order to overcome these drawbacks of autografts, researchers have investigated various artificial materials for nerve gap repair.

To date, 11 conduits are commercially available in the world. Nerbridge (Toyobo Co., Japan), the first artificial nerve designed with a two-layer structure, was approved for use in Japan in 2013 and subsequently approved by the U.S. Food and Drug Administration in 2016.^{6,7} It is composed of an inner collagen spongiform matrix and surrounding outer polyglycolic acid (PGA) fiber mesh conduit providing a favorable micro-environment for nerve regeneration.⁸ The regenerating nerve, guided by the surrounding outer PGA fiber mesh layer, proceeds by displacing the inner collagen bar. All synthetic components biodegrade over time. There are several clinical reports that used this new conduit for repair of peripheral sensory nerves, however its use for motor nerves has rarely been reported to date. Here we describe two cases of traumatic temporal facial nerve injuries repaired with Nerbridge.

CASE 1

A 62-year-old female slipped and fell down, injuring her right temporal region. Frontal muscle paralysis with blepharoptosis was observed after the injury and showed no subsequent improvement (Figure 1-A). One month after injury, an operative exploration was performed under general anesthesia. The temporal branch of the facial nerve was identified and a 16 mm nerve gap was observed. The proximal stump diameter was 1.0 mm and the distal stump was 0.5 mm (Figure 1-B). It was not possible to sew them directly so a 20 mm length of Nerbridge (\varnothing 2.5 mm) was used to interpose this gap. No notable complication was observed postoperatively. Recovery of frontal muscle movement was observed from 5 months after surgery. Although her forehead skin wrinkles and the gap of eyebrow height were not restored to their original state (HB III) (Figure 1-A), the patient was satisfied with the result. Assessment by postoperative photography revealed recovered frontal muscle movement by five months after surgery and that the final elevation distance was comparable to the healthy side (Figure 1-C). The margin reflex distance (MRD) of the injured side recovered almost completely by 10 months after operation. Electromyography at 12 months after surgery showed polymorphic electric discharge, suggesting connection of the injured frontal branch of the facial nerve to the muscle (Figure 1-D).

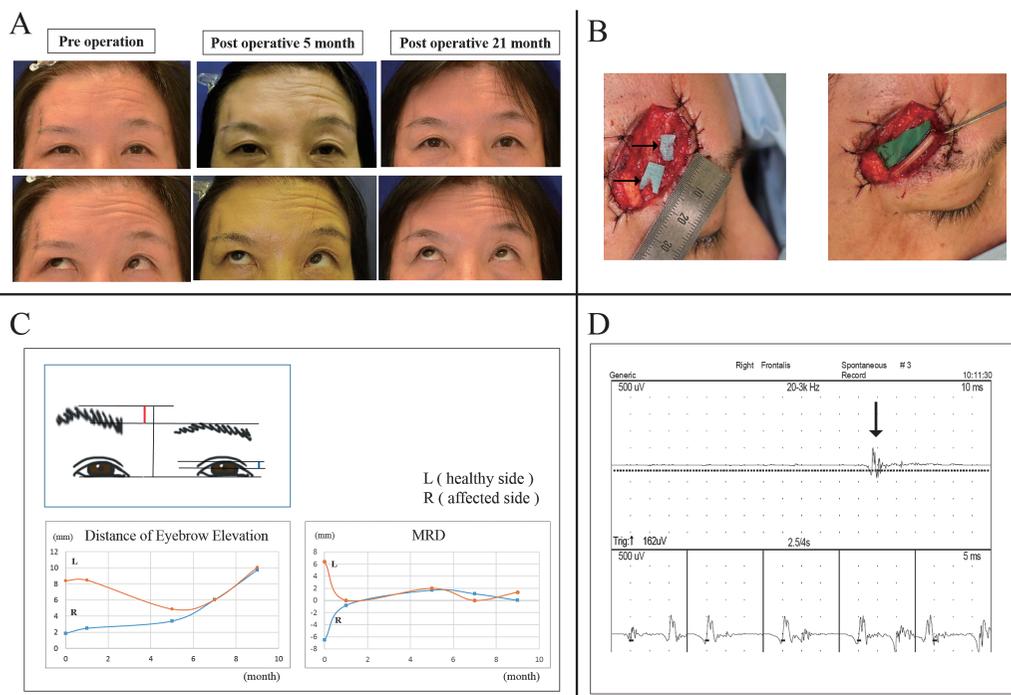


Fig. 1 Preoperative and postoperative findings

Frontal muscle paralysis with blepharoptosis was observed after injury and showed no improvement. Recovery of frontal muscle movement was observed from 5 months after surgery, although forehead skin wrinkles and the gap of eyebrow height did not recover to their original state (HB III). Forward gaze (above). Eyebrow elevation (below) (A). Intraoperative findings. Nerve gap was 16 mm. Distal stump diameter was 0.5 mm and proximal was 1.0 mm (arrow) (left). Nerve defect was bridged with 20 mm Nerbridge (ϕ 2.5 mm) (right) (B). Analysis of postoperative photography. Red line indicates distance of eyebrow elevation and blue line indicates margin reflex distance (MRD) (above). Recovery of frontal muscle movement was observed from 5 months after repair and final elevation distance was comparable to the healthy side (below left). MRD of the affected side recovered almost completely at 10 months after operation. (below right) (C). Electromyogram twelve months after operation showed polymorphic electric discharge (arrow) (D).

CASE 2

A 69-year-old male presented with an injury history similar to the first case. Frontal muscle paralysis with blepharoptosis was observed after injury and showed no subsequent improvement. Senile blepharoptosis contributed to his overall severe blepharoptosis (Figure 2-A). One month after injury, an operative exploration was performed under general anesthesia. The temporal branch of the facial nerve was identified with a 20 mm nerve gap. The proximal stump diameter was 1.0 mm and the distal stump was 0.5 mm (Figure 2-B). Similar to the first case, 25 mm Nerbridge (ϕ 2.0 mm) was used to interpose this gap. No postoperative complication occurred and recovery of the frontal muscle movement was observed from five months after surgery. The eyebrow height gap did not recover completely (HB III), however, the final elevation distance was comparable to the healthy side (Figure 2-C). MRD improvement was unclear, possibly due to senile blepharoptosis concealing frontalis muscle movement. Electromyography 12 months postoperatively showed electric discharge equivalent to the healthy side, suggesting that improvement of the injured nerve was comparable (Figure 2-D).

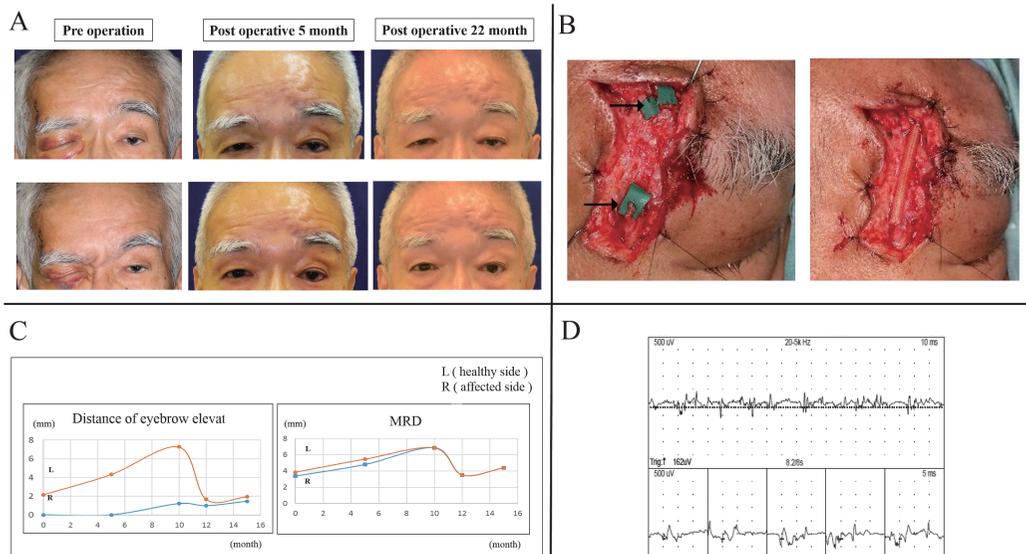


Fig. 2 Preoperative and postoperative findings

The patient was not able to open the affected side of his eyelid due in part to senile blepharoptosis. Recovery of frontal muscle movement was observed from 5 months after repair. The gap of eyebrow height was not improved (A). Intraoperative findings. Nerve gap was 20 mm. Distal stump diameter was 0.5 mm and proximal was 1.0 mm (arrow) (left). Nerve defect was bridged with 25 mm Nerbridge (ϕ 2.0 mm) (right) (B). Analysis of postoperative photography. Recovery of frontal muscle movement was observed from 5 months after repair and final elevation distance was comparable to the healthy side (left). MRD improvement was not clear (right) (C). Electromyogram twelve months postoperatively showed discharge comparable to the healthy side (D).

DISCUSSION

To date, there is no established method for reanimating a paralyzed frontalis muscle by regenerating the severed frontal branch of the facial nerve. A variety of surgical approaches have been performed such as excision of the skin above the ptotic eyebrow or eyebrow lift with fascia transfer.⁹ Facial nerve repair with nerve guide conduits is inadequately reported in clinical and animal studies.¹⁰⁻¹⁶ In clinical cases, some conventional hollow tubes have been applied to facial nerve repair but they have not compared to autologous nerve grafts. Only Neurotube (Synovis Micro Companies Alliance, USA) has a reported clinical outcome of muscle movement recovery, but recovery of more than 60% was attained in only 1/7 of cases (14.2%).¹⁷ In contrast, although it was a preclinical study, Inada et al reported favorable results using a 2-layer polyglycolic acid-collagen conduit.¹⁰ This suggests that the inner collagen filling could facilitate axonal growth via a more suitable condition while inhibiting scar formation between nerve gaps and promoting effective nerve regeneration.

Our study using Nerbridge showed good eyebrow elevation and moderate forward gaze improvement. A histological examination was not performed in this study, however successful motor function was revealed by photographic and electrophysiological assessment. This suggests that Nerbridge improved the movement of frontal muscles, even though some muscular atrophy occurred. In both cases, patients were satisfied with the result and did not need further revision. There is still a possibility that other near branches contributed to recovery, which is sometimes seen clinically. The duration of the preoperative facial nerve palsy is reported to be the only

significant factor related to outcome.⁵ In the two present cases, however, there was no sign of spontaneous recovery at one month after injury. The timing of nerve reconstruction may be clinically important. Conley¹⁸ and May et al¹⁹ suggested that the ideal time was within one month after injury as the results reconstructed at 4 to 6 months have been unsatisfying. Therefore, we selected to perform surgical explorations one month after the injuries. A nerve gap was identified at the injury site in each case. We believe early surgical evaluation of facial nerves is worthwhile in patients who have sustained traumatic damage to their facial skin. Additional similar studies will provide better understanding.

CONCLUSION

Considering that facial nerves are reported to recover incompletely even with autologous nerve repair, our two cases showed reasonable recovery comparable to nerve autografting. This suggests that Nerbridge is a promising alternative for the repair of motor nerve defects.

ETHICS STATEMENT

This study was received Nagoya University Hospital Institutional Review Board approval.

PATIENT CONSENT

Written informed consent was obtained from patients for publication of this case report.

ACKNOWLEDGMENTS

I would like to thank James Curley for the English language review and useful discussions.

CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest, whether they are financial or related to any other relationships, to disclose.

REFERENCES

- 1) Arriaga MA, Brackmann DE. Facial nerve repair techniques in cerebellopontine angle tumor surgery. *Amer J Otol.* 1992;13(4):356–359.
- 2) Samii M, Matthies C. Management of 1000 vestibular schwannomas (acoustic neuromas): the facial nerve-preservation and restitution of function. *Neurosurgery.* 1997;40(4):684–694;discussion 694–685.
- 3) Falcioni M, Taibah A, Russo A, Piccirillo E, Sanna M. Facial nerve grafting. *Otol Neurotol.* 2003;24(3):486–489.
- 4) Gunther M, Danckwardt-Lilliestrom N, Gudjonsson O, et al. Surgical treatment of patients with facial neuromas – a report of 26 consecutive operations. *Otol Neurotol.* 2010;31(9):1493–1497. doi: 10.1097/MAO.0b013e3181f0c524.
- 5) Ozmen OA, Falcioni M, Lauda L, Sanna M. Outcomes of facial nerve grafting in 155 cases: predictive value of history and preoperative function. *Otol Neurotol.* 2011;32(8):1341–1346. doi: 10.1097/

- MAO.0b013e31822e952d.
- 6) Meek MF, Coert JH. US Food and Drug Administration / Conformit Europe-approved absorbable nerve conduits for clinical repair of peripheral and cranial nerves. *Ann Plast Surg.* 2008;60(1):110–116. doi: 10.1097/SAP.0b013e31804d441c.
 - 7) Gaudin R, Knipfer C, Henningsen A, Smeets R, Heiland M, Hadlock T. Approaches to peripheral nerve repair: generations of biomaterial conduits yielding to replacing autologous nerve grafts in craniomaxillofacial surgery. *Biomed Res Int.* 2016;2016:3856262. doi: 10.1155/2016/3856262.
 - 8) Dellon AL, Mackinnon SE. An alternative to the classical nerve graft for the management of the short nerve gap. *Plast Reconstr Surg.* 1988;82(5):849–856.
 - 9) Chait LA, Fayman MS. A modified frontalis sling in the treatment of combined blepharoptosis and facial nerve paresis. *Br J Plast Surg.* 1989;42(5):610–612.
 - 10) Inada Y, Hosoi H, Yamashita A, et al. Regeneration of peripheral motor nerve gaps with a polyglycolic acid-collagen tube: technical case report. *Neurosurgery.* 2007;61(5):E1105–1107;discussion E1107.
 - 11) Guo BF, Dong MM. Application of neural stem cells in tissue-engineered artificial nerve. *Otolaryngol Head Neck Surg.* 2009;140(2):159–164. doi: 10.1016/j.otohns.2008.10.039.
 - 12) Shi Y, Zhou L, Tian J, Wang Y. Transplanting neural stem cells in nerve conduit to promote rats facial nerve regeneration [in Chinese]. *Lin chuang er bi yan hou tou jing wai ke za zhi.* 2012;26(22):1040–1042.
 - 13) Liu H, Wen W, Hu M, et al. Chitosan conduits combined with nerve growth factor microspheres repair facial nerve defects. *Neural Regen Res.* 2013;8(33):3139–3147. doi: 10.3969/j.issn.1673-5374.2013.33.008.
 - 14) Cui Y, Lu C, Meng D, et al. Collagen scaffolds modified with CNTF and bFGF promote facial nerve regeneration in minipigs. *Biomaterials.* 2014;35(27):7819–7827. doi: 10.1016/j.biomaterials.2014.05.065.
 - 15) Matsumine H, Sasaki R, Yamato M, Okano T, Sakurai H. A polylactic acid non-woven nerve conduit for facial nerve regeneration in rats. *J Tissue Eng Regen Med.* 2014;8(6):454–462. doi: 10.1002/term.1540.
 - 16) Suzuki H, Araki K, Matsui T, et al. Value of a novel PGA-collagen tube on recurrent laryngeal nerve regeneration in a rat model. *Laryngoscope.* 2016;126(7):E233–239. doi: 10.1002/lary.25750.
 - 17) Navissano M, Malan F, Carnino R, Battiston B. Neurotube for facial nerve repair. *Microsurgery.* 2005;25(4):268–271.
 - 18) Conley JJ. Facial nerve grafting. *Arch Otolaryngol.* 1961;73:322–327. doi: 10.1001/archotol.1961.00740020330013.
 - 19) May M, Sobol SM, Mester SJ. Managing segmental facial nerve injuries by surgical repair. *Laryngoscope.* 1990;100(10, Pt 1):1062–1067.