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Case Report

Nerve Regeneration Using Polyglycolic Acid-Collagen Tube Following Tumor Resection in The Inferior Alveolar Nerve

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ABSTRACT

A conduit for peripheral nerve regeneration (NERBRIDGE®; Toyobo Co., Japan) in cases of disconnection or deficiency of the peripheral nerve was approved in Japan in 2013. NERBRIDGE® is a polyglycolic acid-collagen (PGA) product derived from porcine skin. The use of NERBRIDGE® has been reported mainly in orthopaedic surgery. Reports on its use for sensory nerve injuries in the oral region are scarce. This case report describes a case of significant sensory recovery obtained by nerve repair using NERBRIDGE® in a patient with schwannoma-induced inferior alveolar nerve resection. At the 1-year postoperative evaluation, sensory nerve recovery using the two-point discrimination test was confirmed.

Introduction

When the inferior alveolar nerve must be resected during mandibular tumorectomy, the damaged innervation results in the permanent loss of sensation. Nerve reconstruction is usually performed with an autologous nerve graft, but there is a risk of neuropathy in the nerve-donor site. The nerve conduit, which is an artificial material, has been used for the management of nerve amputation and deficiency, but reported cases involving mandibular tumors are few [1-3]. In our patient, a neurogenic tumor developed in the inferior alveolar nerve, and it was difficult to determine the margin of the tumor. Therefore, the safety margin was set as large as possible. Nerve regeneration of the mandible with an enhanced method was planned. Nerve reconstruction was performed using a polyglycolic acid-collagen (PGA) tube at the time of tumor resection of the inferior alveolar nerve.

Case Report

A 35-year-old female with no other medical history was referred for the treatment of paresthesia in the area around the left lower lip. Initial examination revealed an abnormal tingling sensation in the left lower lip and mental regions, without spontaneous pain or local swelling. No abnormal findings were observed in the regional lymph nodes. Panoramic radiography revealed an expansion of the mandibular canal from the left molar region to the mandibular angle. Computed tomography showed vertical and lateral expansion in the wall of the mandibular canal and a radiolucent fusiform area unconnected to the teeth. Magnetic resonance imaging revealed a mass with low signal intensity on T1-weighted images and high signal intensity on T2-weighted images. The axial image revealed a region with a clear boundary that accompanied the target sign with uniform contrast. Coronally, the mass occupied a large portion of the mandibular canal.

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Based on these findings, a benign intraosseous tumor of the peripheral nervous system derived from the inferior alveolar nerve was suspected. A benign neoplasm was resected from the mandible using a submandibular approach under general anaesthesia. The cortical bone flap was removed (Figures 1 & 2), which revealed a lesion surrounded by a fibrous capsule in the expanded mandibular canal (Figure 3).

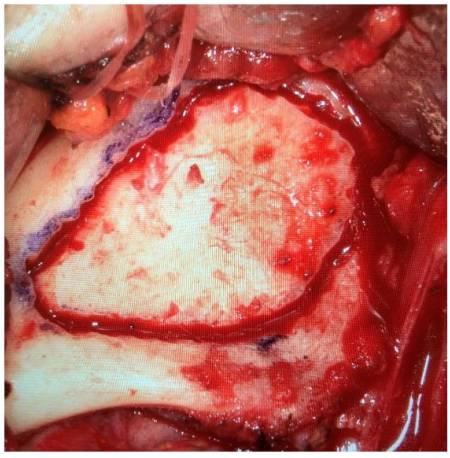

Figure 1: Mandibular buccal cortical fragment prepared with a round bur.

Figure 2: Removed the cortical bone fragment.

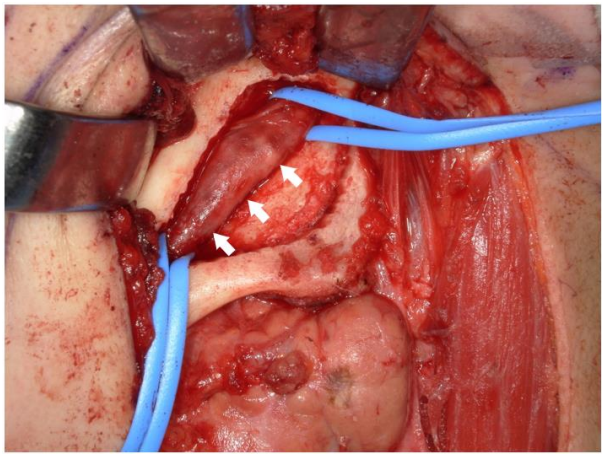

Figure 3: Tumor exposed by careful cutting. The length of the lesion is 20-mm (arrows).

The lesion was a firm ivory mass, which was inseparable from the inferior alveolar nerve. Before resecting the lesion, a 2/0 silk surgical suture was threaded through the anterior side of the lesion to prevent the nerve from being pulled deeper into the canal (Figure 4). An 8/0 nylon thread was threaded through the nerves, anterior and posterior to the lesion. The lesion was excised together with the nerve with a safety margin of 5 mm. The cut ends of the nerve were bridged using NERBRIDGE® (Toyobo Co., Japan). NERBRIDGE® was immersed in saline before being used for the reconstruction. The sutures were threaded from the outside to the inside, 2-mm from the edge of the NERBRIDGE® material. The suture was pulled, and the nerve stump was gently pulled into the NERBRIDGE® material (Figures 5 & 6). The cortical bone flap was repositioned and fixed in place with a titanium osteosynthesis miniplate (Figure 7), and then, the wound was closed.

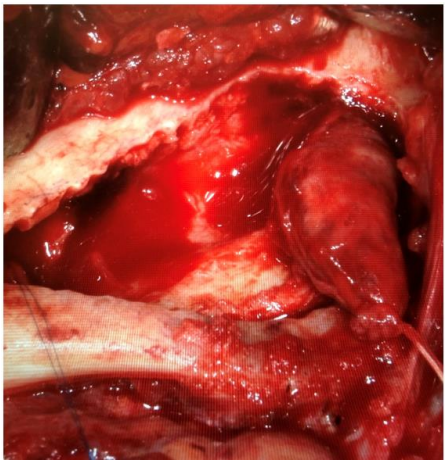

Figure 4: The anterior margin of tumor resection was prethreaded with 8/0 micro thread before resection. A 2/0 silk surgical suture was threaded through the anterior side of the lesion.

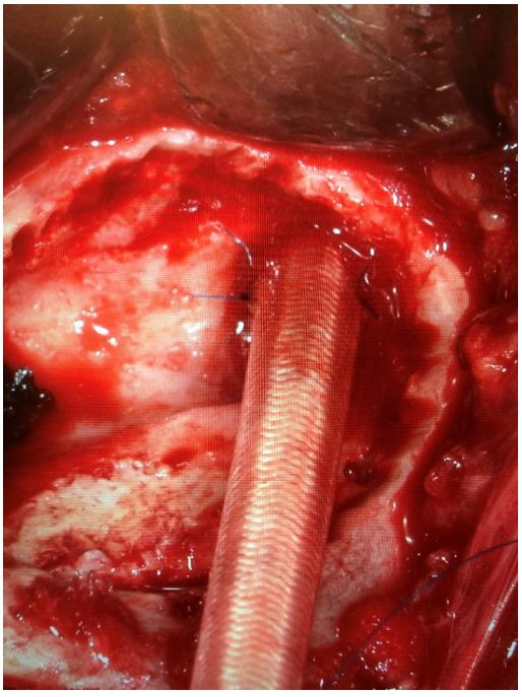

Figure 5: The NERBRIDGE® and nerve were sutured from the central end, where the nerve tends to pulled deeper into the canal.

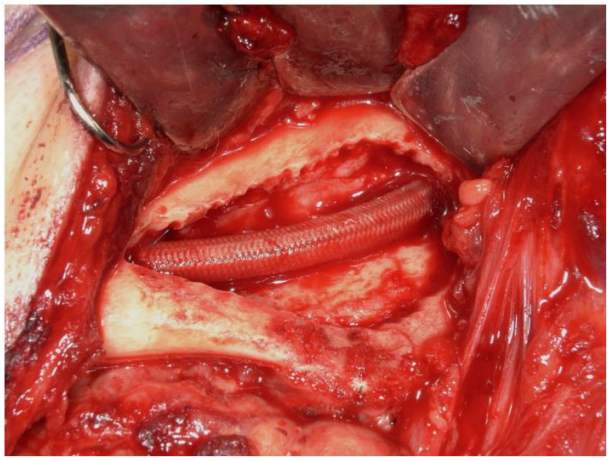

Figure 6: Result after the NERBRIDGE® is sutured. Two sutures at each point are placed with an 8/0 nylon thread. The nerve defect is bridged with 30-mm of NERBRIDGE® (Ø 4.0-mm).

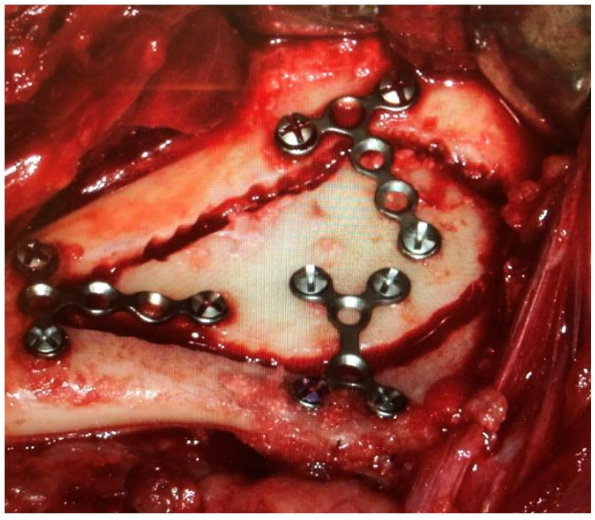

Figure 7: The cortical bone flap was repositioned and fixed in place with a titanium osteosynthesis miniplate.

A histopathological examination of the surgical specimen revealed that it was a benign schwannoma with no residual tumor at the resection margins. Sensory inputs at the lips and chin were evaluated regularly after surgery using a two-point discrimination test. The values of the two-point discrimination tests were 25 mm at 2 weeks, 20 mm at 3 months, 12 mm at 6 months, and 10 mm at 1 year. At 1-year postoperatively, the tactile sensation on the surgical side was mostly recovered. Finally, the titanium plate was removed one and a half years postoperatively. Intraoperative findings confirmed bone healing of the mandibular cortical bone flap.

Discussion

In the past, when a peripheral nerve was severed due to trauma or surgery, it was sutured if direct suturing was possible. However, if the severance distance was long or direct suturing difficult, the only option was autologous nerve grafting [4]. However, autologous nerve transplantation has disadvantages, such as neuropathy in the harvested area and the inability to select the nerve thickness. To circumvent these disadvantages, a method was devised to bridge severed nerves using artificial tubes [5]. Nerve regeneration using tube-like materials is known as tubulation [6]. According to a study on the process of nerve regeneration via tubulation, a fibrin matrix containing various neurochemical factors is formed within the tube during the first step [7]. Next, the capillary extension of both the nerve stumps into the fibrin matrix was performed. As the capillaries extend, Schwann cells migrate into the fibrin matrix from both nerve stumps. Finally, the axons are extended into the fibrin matrix from the proximal nerve stump. However, a conventional hollow PGA tube can repair only small gaps of less than 30 mm in minor sensory nerves, such as the digital nerves of the fingers [8].

Therefore, a PGA nerve guide tube filled with a collagen sponge was developed to enhance nerve regeneration. NERBRIDGE® is the first peripheral nerve regeneration induction tube approved in Japan in 2013, and is a resorbable tube composed of cylindrically braided PGA filled with a collagen sponge. Inada *et al.* reported favourable results using a two-layer PGA conduit in a preclinical study [9]. The result suggests that inner collagen filling could facilitate axonal growth via a more suitable condition, while inhibiting scar formation in the gap between the severed nerve and promoting effective nerve regeneration. Eight types of NERBRIDGE® are available, ranging from 0.5-mm to 4-mm in diameter, and with a choice of tubing thickness according to the cutting nerve. Therefore, unlike autologous nerve grafts, there is no neuropathy at the harvested site and the time for nerve harvesting can be omitted. In the field of orthopaedic surgery, there are many clinical reports on nerve regeneration using NERBRIDGE®. Relatively good nerve reconstruction and sensory recovery have been reported in the hand nerves [1].

Weber *et al.* reported that nerve repair in the hand using the PGA conduit was comparable to that with autologous nerve transplantation [8]. In contrast, in the oral region, immediate reconstruction after tumor resection has been reported to show a trend toward sensory recovery in the inferior alveolar and lingual nerves [10]. Fujishiro *et al.* reported that patients who underwent reconstruction of the inferior alveolar nerve with NERBRIDGE® for a 20-mm nerve defect after mandibulectomy required 10 months for sensory recovery [3]. A similar course was observed in our patient. In our case, sensory recovery took slightly longer, probably because of the bigger nerve defect (a longer gap between the severed ends). A Semmes-Weinstein monofilament test was not performed in our case. Instead, successful tactile testing of the injured side using a two-point discrimination test was conducted. The patient was satisfied with the results and further revision was not indicated.

In conclusion, NERBRIDGE®, a polyglycolic acid-collagen tube, is a promising alternative for the regeneration of sensory nerve defects.

Funding

None.

Competing Interests

None.

Ethical Approval

The ethics committee required patient consent for this technical note.

Patient Consent

Patient consent was obtained to publish the clinical intraoral photographs without any patient identification.

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