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Original Article

RECONSTRUCTION OF THE INFERIOR ALVEOLAR NERVE BY AUTOLOGOUS GRAFT: A RETROSPECTIVE STUDY OF 20 CASES EXAMINING DONOR NERVE LENGTH

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Abstract

The purpose of this study was to confirm the length and kind of donor nerves used in nerve grafts for reconstruction of inferior alveolar nerve defects. The authors conducted a retrospective study of surgeries that were performed between 1977 and 1996. A total of 20 patients underwent nerve grafting procedures during this period. The greater auricular nerve was selected as the donor nerve in 16 cases, while the sural nerve was selected in 4. Mean lengths of donor nerves were 7.28 ± 1.6 cm and 11.5 ± 3.4 cm for the greater auricular and sural nerves, respectively. As indicated, the sural nerves were significantly longer ($p<0.01$). Mean lengths of donor nerves grafted for partial resection and hemi-mandibulectomy were 7.23 ± 1.6 cm and 10.8 ± 3.4 cm, respectively. Statistical analysis indicated that grafts used in the hemi-mandibulectomy group were significantly longer ($p<0.05$). In terms of types of donor nerve used in mandibulectomies, the greater auricular nerve was used in the majority of partial resections, and the sural nerve was employed for hemi-mandibulectomy.

Key words: Inferior alveolar nerve—Nerve grafting—Greater auricular nerve—Sural nerve—Microsurgery

INTRODUCTION

The inferior alveolar nerve is frequently damaged or severed during mandibulectomy. Patients whose inferior alveolar nerve has been damaged experience a number of different problems, including bite wounds and burn injuries of the lower lip. These problems

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result from permanent post-operative neurosensory disturbances. In such cases, nerve repair procedures such as nerve suturing or grafting are performed in an attempt to recover sensory function[4–8,10,16].

We have been performing nerve grafting to repair damaged inferior alveolar nerves and restore sensory function since 1977. The results of sensory recovery have been favorable, and the authors have reported the surgical techniques and usefulness of the procedure[11–13, 20,21]. However, no studies have investigated in detail of the kinds and lengths of donor nerves in nerve grafting procedures or the relationships with types of mandibulectomy[3]. The authors therefore conducted a retrospective study of nerve grafting cases performed in our department.

MATERIALS AND METHODS

The cases examined in this retrospective study included those between 1977 and 1996 in whom free autologous nerve grafts were performed in an attempt to repair defects of the inferior alveolar nerve following mandibulectomy. The 20 cases selected were those in which the type and length of donor nerve, in addition to the type of mandibulectomy performed, were recorded in the case records. Subjects included 6 females and 14 males between 15 and 63 years old. Mean age was 35.3 ± 15.4 years (females: 34.3 ± 11.5 years; males: 35.7 ± 17.2 years). Diagnoses included 18 cases of ameloblastoma and 2 cases of odontogenic cyst (Table 1).

Tumor resections by the extraoral approach were followed by reconstruction of the nerve and mandible. Donor nerves were excised 15–20% in excess of the inferior alveolar nerve defect to avoid any tension following grafting[17–19]. Nerve grafting was performed under surgical microscopy. Neurorraphy was performed at the proximal and distal stumps using 4 to 8 epineurial sutures composed of 8-0 to 10-0 nylon or absorbable materials[21].

Items examined in this study included type and length of donor nerves, length and type of donor nerve used in mandibulectomy, and type of mandibulectomy performed. Relationships between these items were examined, and data were statistically analyzed. The mean length of donor nerve by type was determined, and the Mann-Whitney U-test was employed to analyze differences. Mandibulectomies were categorized into partial resection (including segmental and marginal resections) and hemi-mandibulectomy groups. The Mann-Whitney U-test was employed to analyze differences in the lengths of donor nerves used between the mandibulectomy categories. For relationships between donor nerve type and type of mandibulectomy performed, Fisher's exact probability test was employed to identify significant differences. Statistical analysis and significance were calculated using SPSS Version 11 for Windows.

RESULTS

1. Donor nerve type and length

The greater auricular nerve and sural nerve were selected as donor nerves. In 16 of the 20 cases (80%), the greater auricular nerve was utilized, and, in 4 cases (20%), the donor nerve was the sural nerve (Figs. 1, 2). Minimum, maximum, and mean lengths of grafted donor nerves were 4.0, 16.0, and 8.63 ± 2.7 cm, respectively. Minimum, maximum, and mean lengths of grafted greater auricular nerves were 4.0, 10.0, and 7.28 ± 1.6 cm, respectively, while those of the grafted sural nerves were 8.0, 16.0, and 11.5 ± 3.4 cm, respectively. Statistical analysis indicated that, in terms of donor nerve length, the sural nerve was employed as a longer graft ($p<0.01$) (Fig. 3).

2. Donor nerve length according to mandibulectomy type

The partial resection group included 15 cases (14 cases of segmental resection, 1 case of marginal resection), while the hemi-mandibulectomy group included the other 5 cases. Mean lengths of donor nerve employed were 7.23 ± 1.6 cm and 10.8 ± 3.4 cm, respec-

Table 1 Subjects

No.	Sex	Age	Clinical diagnosis	Pathological diagnosis	Year	Donor nerve	Mandibulectomy
1	F	22	Ameloblastoma	Ameloblastoma	1977	Greater auricular n.	Hemi-mandibulectomy
2	M	30	Ameloblastoma	Ameloblastoma	1978	Greater auricular n.	Segmental resection
3	M	15	Ameloblastoma	Ameloblastoma	1979	Greater auricular n.	Segmental resection
4	M	42	Ameloblastoma	Ameloblastoma	1980	Greater auricular n.	Segmental resection
5	F	33	Ameloblastoma	Ameloblastoma	1980	Greater auricular n.	Segmental resection
6	M	51	Ameloblastoma	Ameloblastoma	1980	Greater auricular n.	Segmental resection
7	F	28	Ameloblastoma	Ameloblastoma	1980	Greater auricular n.	Segmental resection
8	F	28	Ameloblastoma	Ameloblastoma	1980	Greater auricular n.	Segmental resection
9	M	21	Ameloblastoma	Ameloblastoma	1981	Greater auricular n.	Segmental resection
10	M	56	Ameloblastoma	Ameloblastoma	1981	Greater auricular n.	Segmental resection
11	M	51	Ameloblastoma	Ameloblastoma	1984	Greater auricular n.	Segmental resection
12	M	16	Ameloblastoma	Ameloblastoma	1984	Sural nerve	Hemi-mandibulectomy
13	M	56	Ameloblastoma	Ameloblastoma	1984	Greater auricular n.	Hemi-mandibulectomy
14	M	35	Ameloblastoma	Ameloblastoma	1985	Sural nerve	Segmental resection
15	M	28	Ameloblastoma	Ameloblastoma	1985	Greater auricular n.	Segmental resection
16	F	41	Ameloblastoma	Ameloblastoma	1985	Sural nerve	Hemi-mandibulectomy
17	F	54	Ameloblastoma	Odontogenic cyst	1988	Sural nerve	Hemi-mandibulectomy
18	M	21	Ameloblastoma	Ameloblastoma	1989	Greater auricular n.	Segmental resection
19	M	63	Ameloblastoma	Odontogenic cyst	1994	Greater auricular n.	Segmental resection
20	M	15	Ameloblastoma	Ameloblastoma	1994	Greater auricular n.	Marginal resection

tively. In terms of donor nerve length, statistical analysis indicated that grafts used in the hemi-mandibulectomy group were significantly longer ($p<0.05$) (Fig. 4).

3. Donor nerve types used in mandibulectomies

In the partial resection group, the sural nerve was employed in one case (6.7%), and the greater auricular nerve was employed in 14 (93.3%). In the hemi-mandibulectomy group, sural nerve grafts were used in 3 cases (60%) and the greater auricular nerve in 2 (40%) (Table 2). A tendency ($p<0.005$) toward grafting the sural nerve for hemi-mandibulectomy and the greater auricular nerve for partial resection was observed.

DISCUSSION

Various procedures for repair of inferior alveolar nerve defects have been reported[4,8,10,16]. Of these, free autologous nerve grafting is the most widely employed. Since it was first reported by Hausamen *et al.*, this method has gained wide acceptance in field of oral and maxillo-facial surgery[4–7]. In Japan, since the initial report published by Noma *et al.* from our department, we have been performing free autologous nerve grafting. The results of sensory recovery have been favorable, and we have reported the surgical techniques and usefulness of this method[8,11–13,16,20]. However, no reports have investigated in detail of the kinds and lengths of donor nerves or their

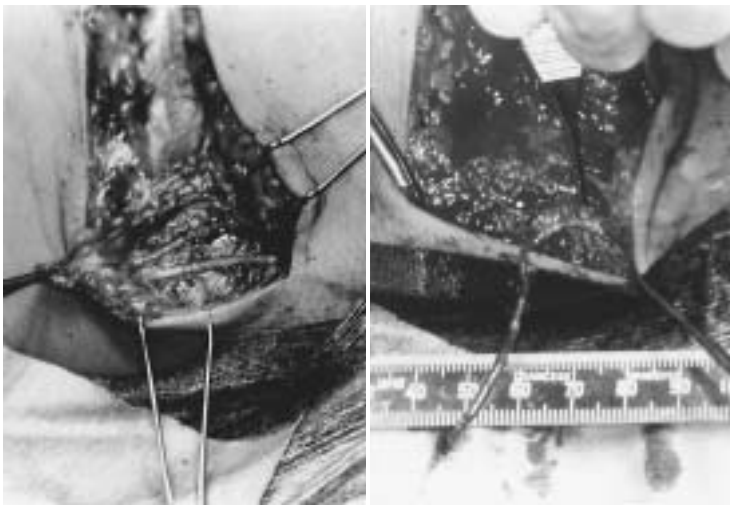

Fig. 1 The greater auricular nerve

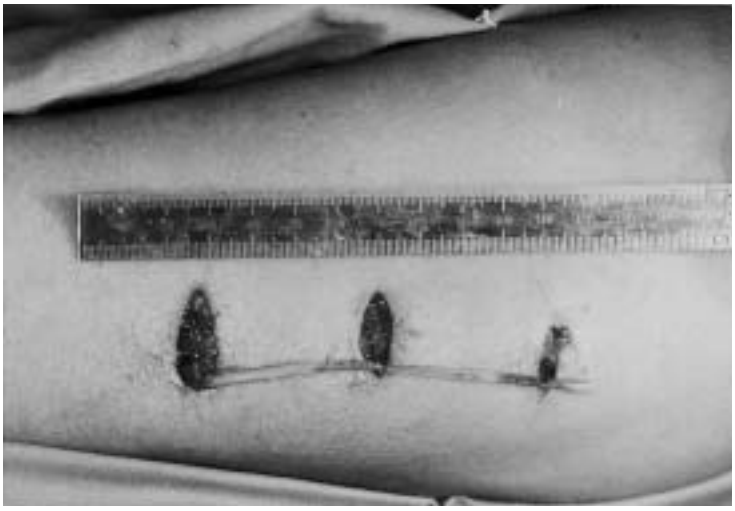

Fig. 2 The sural nerve

relationships with types of mandibulectomies[3]. Therefore, in order to elucidate the clinical factors mentioned above, we conducted a retrospective study involving 20 nerve graft cases and discussed the criteria for selecting donor nerves.

For greater auricular nerve grafts, reports have described graft segments of 1 cm[1], 1.3–3 cm[14], 6 cm[17], and 9 cm[9,12,17]. Noma *et al.* reported that nerve defects resulting from resection of benign tumors of the mandible usually measure 7 to 9 cm and that the greater auricular nerve can supply 8–10 cm of graft segment[11,12]. The present study identified that graft segments measuring 4–10 cm (mean length 7.28 ± 1.6 cm) were used, confirming the reported data. In addition, the reason that we employed the greater auricular nerve was

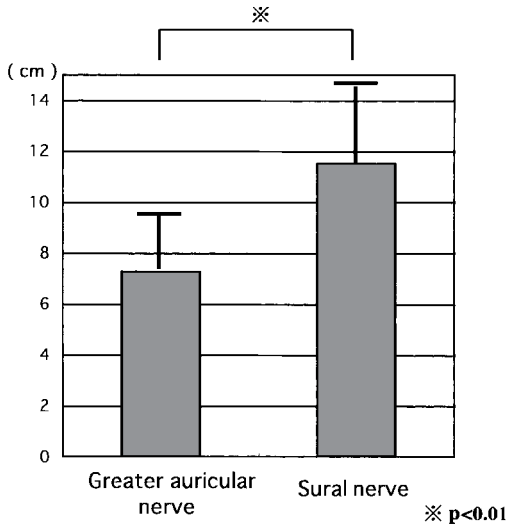

Fig. 3 Donor nerve type and length

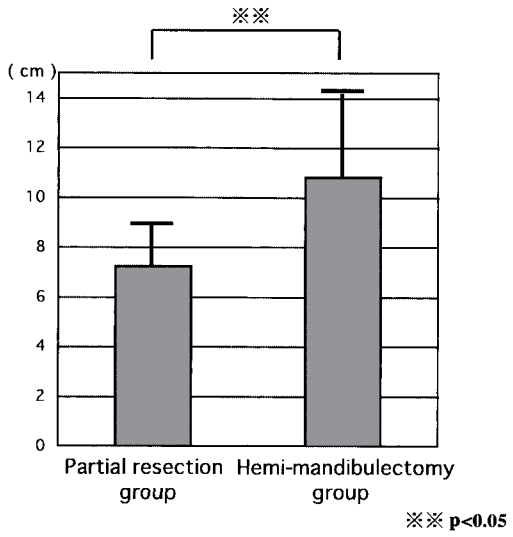

Fig. 4 Donor nerve length according to mandibulectomy type

Table 2 Donor nerve types used in mandibulectomies

Donor nerve \ Mandibulectomy		Partial resection group	Hemi-mandibulectomy group
Greater auricular n.	(n=16)	14 cases	2 cases
Sural nerve	(n= 4)	1 case	3 cases
Total	(n=20)	15 cases	5 cases

that the nerve can be harvested using the same incision line used during mandibulectomy. Another factor is that, because the area controlled by the greater auricular nerve is limited to the auricle and surrounding region, discomfort resulting from donor site morbidity is minimal[12]. Harvesting graft segments measuring 10 cm is possible, allowing transplants in large nerve defects resulting from hemi-mandibulectomy. However, Wessberg *et al.* have reported that, although harvesting greater auricular nerves measuring up to 6 cm is easy, longer segments are smaller in diameter than the inferior alveolar nerve and can be bifurcated in rare instances, producing unfavorable conditions for nerve regeneration[19]. Wessberg *et al.*, however, did not conduct studies examining the degree of sensory perception capable of being restored. In 1986, we published a report investigating the process of sensory restoration in 8 cases and re-examined the length of donor nerves used as grafts in each case[12]. The results indicated that graft segments measuring 4–9 cm were employed (mean length 7.18 ± 1.7 cm), and that satisfactory sensory restoration was achieved. Nerve segments up to 9 cm therefore seem feasible for greater auricular nerve grafting procedures.

For sural nerve grafts, reports have described graft segments of 6 cm[17,18], 10 cm[17], and 20 cm[4], substantially longer than greater auricular nerve segments. Wessberg *et al.* stated that the advantages associated with using the sural nerve include that fact that it has almost the same diameter as the inferior alveolar nerve,

is indicated when cervical incisions are undesirable, and produces segments longer than 6 cm[19]. Reported disadvantages include having to create a separate incision in the lateral region of the ankle when harvesting and donor site morbidity of the calcaneal region[2–5]. The authors employed the sural nerve in cases where significant tumor expansion had occurred. In these cases, a large portion of the central inferior alveolar nerve was resected, necessitating a graft of a longer nerve segment. These donor nerves measured 8–16 cm in length (mean length 11.5 ± 3.4 cm). Of these, 75% exceeded 9 cm, and all were used in cases of hemi-mandibulectomy. Based on this clinical experience, the authors believe that sural nerve graft is indicated in cases where a donor nerve over 9 cm is required. In terms of sensory restoration, some cases have displayed excellent recovery after 6 months[4], while others have shown good recovery after 2 years. Anesthesia of the lower lip has been reportedly present after 12 months in some cases[17]. Due to the fact that the methods of assessment were ambiguous, we can not conclude that there is a uniform opinion.

This research has confirmed that sural nerves were selected for hemi-mandibulectomies when nerve defects were quite large and that greater auricular nerves were employed for partial resection. Based on our investigation, we suggest that a length of 9 cm is appropriate as the criterion for which donor nerve should be selected. However, the influential clinical criteria include not only the length of the donor nerves but also the prognosis for sensory recovery based on kind of donor nerves[15], anatomical factors such as nerve diameter and branching[2,18,19], and donor site morbidity[14]. We are attempting to establish new criteria for selecting donor nerves based on these factors.

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