Interposition Graft Repair of a Rat Facial Nerve Defect With and Without Donor Nerve Interfascicular Dissection

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Introduction

Donor nerve autografting remains the gold standard for long-gap nerve repair. Limitations of nerve autografts include the need for a second surgical site, donor site morbidity, and limited availability. In cases where multiple long nerve grafts are required, (for example cross-face nerve grafting), intraneural or interfascicular dissection (IFD) may be employed to obtain multiple interposition grafts from a single donor nerve. However, there exists a theoretical risk of increased axonal loss in nerve grafts that have undergone IFD due to epineurial disruption., This study compares functional and histomorphometric outcomes in a rat facial nerve gap model with and without IFD of the donor nerve.

Materials and Methods

Female Lewis rats, 200-250 g each, underwent conditioning to handling, titanium head fixation device implantation, and conditioning to head fixation testing to allow for quantitative tracking of C1 whisker displacement on both sides using laser micrometers (MetraLight, Santa Mateo CA) (Fig. 1). Four week later, animals were placed back under ketamine/medetomidine anesthesia to expose the facial nerve (Fig. 2). Following resection and proximal ligation of the marginal branch on both sides of the face (to eliminate its known contribution to whisking), an 8 mm segment of the buccal branch of the facial nerve on the left side was sharply excised. In separate donor female Lewis rats, the sciatic nerves were excised. One isograft was kept intact, while IFD was performed on the other and the largest fascicle preserved. Isografts were trimmed to 1 cm in length at their mid-portion, inlaid in antidromic fashion across the buccal branch defect, and secured with 10-0 nylon sutures under microscopic visualization (n = 7 whole isografts, n = 7 IFD isografts) (Fig. 3). Functional recovery was tracked by quantitative measurement of C1 whisker displacement during 5 minute trials over the course of 14 weeks, after which nerves were excised and ultrathin toluidine blue stained sections obtained for histomorphometric analysis.

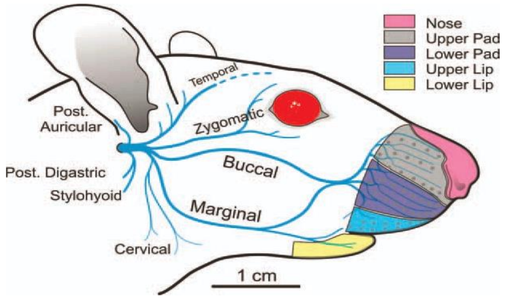

Figure 1. *The facial nerve in the rat.* The nerve demonstrates a branching pattern similar to that seen in humans. While some variation occurs, a well defined buccal and marginal branch are always clearly identifiable; both contribute to whisking.

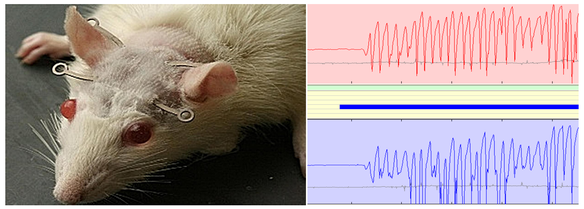

Figure 2. *Head fixation and whisker tracking in the rat.* Left: The healthy interface between the calvarium, scalp, and titanium head fixation device is demonstratrated. Right: Tracings of C1 whisker displacement (red – right, blue - left). Solid dark blue bar represents scented air puff delivery. Note triggered whisking.

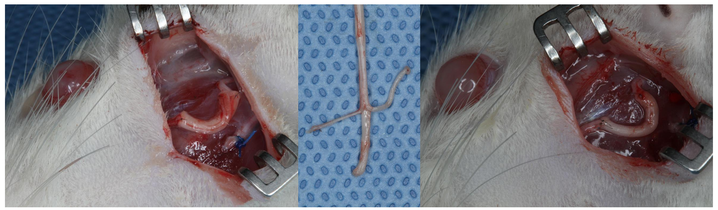

Figure 3. *Grafting of buccal branch gap.* Left: A whole-thickness 1 cm long sciatic nerve isograft is inlaid across the 8 mm gap. Note the resected marginal branch of the facial nerve below (marked with blue polypropylene suture). Center: Dissection of sural nerve isograft. Right: Dissected isograft inlaid across gap.

Results

Quantitative analysis revealed no differences in functional recovery between animals implanted with whole isografts versus dissected isografts (Fig. 4) ($p > 0.05$, t-test, all time-points). Histomorphometric analysis revealed no differences in the ratio of myelinated axon counts between the proximal and distal segments of the buccal branch relative to the inlaid isograft (Fig. 5) (Whole isograft group, mean = 533.5, SD = 599; dissected isograft group, mean = 541.8, SD = 1356; $p > 0.05$, t-test).

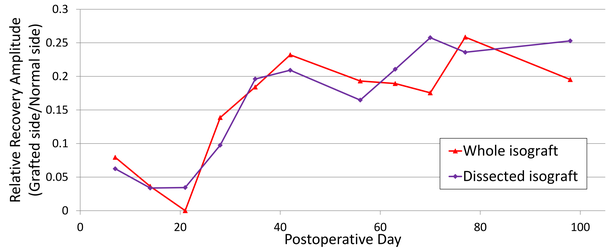

Figure 4. *Functional recovery of whisking.* The average relative ratio of the maximum C1 whisking activity between grafted and control sides within each animal demonstrated no difference between groups at any time point.

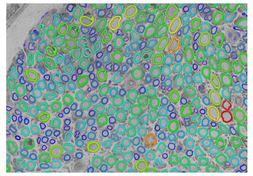

Figure 5. *Histomorphometric analysis of buccal nerve segments.* Semi-automated analysis of myelinated axon counts between the proximal and distal segments of the buccal nerve demonstrated no differences between groups (Bitplane Imaris v8.2, Oxford Instruments).

Conclusions

This study demonstrated no difference in functional recovery nor histomorphometric features between groups undergoing interposition grafting with and without IFD of the donor nerve. These findings are particularly relevant to situations where multiple long nerve grafts are required, such as cross-face nerve grafting.