Hydrogel Sutureless Facial Nerve Repair: Pilot Clinical Investigation

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ABSTRACT

Objectives: Traditional suture repair of the facial nerve (FN) can be technically challenging and time consuming, particularly when performed on the intracranial segment. This study reports the surgical outcomes of a novel, rapidly applied, hydrogel sutureless nerve repair (HSNR) technique for the FN.

Study Design: Retrospective chart review.

Methods: HSNR consisted of nerve alignment with fibrin glue, followed by polyethylene glycol hydrogel encasement for tensile strength. Medical records of patients repaired with the HSNR technique were reviewed. FN function was the primary outcome measure.

Results: Patient one had 20 years of progressive facial palsy secondary to intranuclear perineurium extending from the tympanic segment to the brainstem. Middle fossa HSNR yielded return to baseline FN function with good eye closure after 1 year. Patient two’s FN was sacrificed from the stylomastoid foramen to distal to the pes to remove a squamous cell carcinoma. At six months, he had full eye closure and slight movement of the lower branches. Total HSNR time was less than 10 minutes for each case.

Conclusions: HSNR repair is an appealing alternative to traditional techniques as it provides excellent tensile strength, simplifies neurosurgery (particularly intracranially), reduces intraoperative time, and yields results equivalent to conventional suture neurosurgery.

INTRODUCTION

Suture neurosurgery under microscopic magnification has been considered the gold standard for repair but this method can be technically challenging and time consuming.1 Furthermore, suture is traumatic leading to scar formation that contributes to post-operative complications of synkinesis and neuroma formation.2,3 Nerve repair at the cerebellopontine angle is further complicated by limited exposure and a lack of epineurium, which provides the tissue strength to hold suture. In order to address these concerns, surgeons have investigated sutureless techniques using fibrin sealants and similar materials.4,5 The primary concern with fibrin sutureless techniques is poor tensile strength. To address these concerns we utilized a HSNR technique.

MATERIALS AND METHODS

Hydrogel Sutureless Nerve Repair Technique
1) Fibrin and PEG materials are thawed and separated of in 4 separate syringes
2) Fibrin 1 is first applied to the nerve ends. It is important to completely surround the nerve end with the fibrin glue. Approximately 0.2 to 0.4 cc suffices to coat the nerve ends.
3) An equal volume of Fibrin 2 is then applied to the nerve end. Once Fibrin 2 is applied the glue hardens rapidly. If the ends do not align well they can be gently approximated while the glue is drying. The ends should be held in close proximity for 60 seconds.
4) PEG 1 is then applied to the coaptation site in a circumferential fashion. If necessary, rotate the nerve to facilitate complete exposure. Use just enough to coat the coaptation site circumferentially.
5) PEG 2 is then applied, polymerizing the hydrogel.

RESULTS

The medical records of two patients with transected facial nerves repaired with the below HSNR technique were retrospectively reviewed.

<table>
<thead>
<tr>
<th>Patient #</th>
<th>Age/SEX</th>
<th>Etiology of injury</th>
<th>Location of transection</th>
<th>Graft</th>
<th>Pre-operative House-Brackmann</th>
<th>Post-operative House-Brackmann (Follow up in months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>47/M</td>
<td>Nerve sacrifice due to intranuclear perineurium</td>
<td>Brainstem to tympanic segment</td>
<td>Greater auricular nerve</td>
<td>Grade V</td>
<td>Grade V (12)</td>
</tr>
<tr>
<td>Two</td>
<td>46/M</td>
<td>Nerve sacrifice due to squamous cell carcinoma</td>
<td>Stylo-mastoid foramen to pes anserinus</td>
<td>Axogen graft</td>
<td>Grade I</td>
<td>Grade V (6)</td>
</tr>
</tbody>
</table>

Table 1. Characteristics, etiology of injury and pre- and post-operative House-Brackmann grade are shown.

DISCUSSION

We found that HSNR can be quickly performed with a simple 2-step coaptation of nerve ends. Following application of the fibrin, nerve stumps can be easily placed into correct microanatomical alignment. The polyethylene glycol placed around the fibrin forms a cylinder around the repair providing increased tensile strength without disrupting proper alignment. The technique was found to be easily reproducible, decrease operative time and have similar results to traditional techniques.

Traditional suture neurosurgery although effective at re-approximating transected nerve ends is time consuming, technically challenging and especially with certain areas, such as the skull base with a middle fossa exposure. Repair of the intracranial segment of the facial nerve is more complicated than other peripheral nerve repair. In addition to the narrow exposure, the nerve lacks epineurium and is constantly displaced by the pulsation of cerebrospinal fluid.6 In the periphery, facial nerve repair is also complicated by the post-operative development of synkinesis and neuroma formation, which has been associated with abnormal nerve regeneration across nerve repair sites.2,7 Therefore, surgeons have investigated alternative options for nerve repair. “Surgical glues” such as Tisseeled have been used as an alternative.8

We have presented two patients using the HSNR technique. The first patient’s facial paralysis had been present for a long period of time, greatly limiting the likelihood of recovery to normal or near normal function. The second patient had the potential to assess for return of function, but he died too soon to assess long term outcomes. While these cases do pose significant limitations, they do demonstrate the feasibility and efficiency of the HSNR technique.

CONCLUSIONS

HSNR is a simple, efficient, and potentially efficacious alternative to traditional suture neurosurgery. The addition of hydrogel to fibrin nerve repair provides the necessary tensile strength and deters neuroma formation. A clinical trial will be needed to determine the relative value and efficacy of the HSNR technique.

REFERENCES


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