Neurona may form as a result of nerve transection or damage causing pain and significantly impairing the quality of life. The natural consequence of nerve transection is Wallerian degeneration at the distal stump and intensive proliferation of regenerating axons proximally to the lesion site.

In adverse circumstances such as a large nerve defect, increased inflammation, foreign body in affected site, delayed primary surgery and others the natural potential of regenerative process may be inhibited. When sprouting axons cannot reach the distal part of affected nerve, proliferation of nerve fibers in proximal stump may lead to neurona formation.

A number of methods have been used in the experimental studies regarding neurona prevention and treatment. The variety of techniques have been proposed from simple resection to challenging end-to-side neurorraphy. It is confirmed that the crucial aspect to prevent neurona formation is a conception of natural barrier isolating injured nerve from surrounding inflammation and scar tissue.

To develop optimal method of preventing as well as treatment of neurona formation, we tested the epineural sheath jacket (ESJ) as a new technique of neurona management in the rat sciatic nerve model. Epineural sheath is a natural integral component of the nerve and as such provides optimal conditions facilitating nerve protection. It is also easily harvestable and expresses pronounced regenerative and proangiogenic markers supporting nerve regeneration. The application of epineural sheath jacket over proximal stump of transected nerve may serve as a protective barrier against the regional inflammatory response and preventing nerve fascicular escape. Since epineural sheath is naturally occurring material, applying the ESJ would eliminate the risk of inflammatory response of foreign body with its further complications.

**Introduction**

**Methods**

Rats were divided into six different experimental groups of six animals in each:

<table>
<thead>
<tr>
<th>Groups No.</th>
<th>Groups</th>
<th>Purpose of Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>G1</td>
<td>To test the efficacy of ESJ application in prevention of neurona formation and to compare to contemporary methods using current standard technique– musculocutaneous burrying.</td>
</tr>
<tr>
<td>2</td>
<td>G2</td>
<td>To test ESJ application combined with burying it into adjacent muscle is more effective than ESJ application alone.</td>
</tr>
<tr>
<td>3</td>
<td>G3</td>
<td>To test ESJ application combined with fat graft injection into ESJ is more effective than ESJ application alone.</td>
</tr>
<tr>
<td>4</td>
<td>G4</td>
<td>To test ESJ application combined with fat graft injection into adjacent muscle is more effective than ESJ application alone.</td>
</tr>
<tr>
<td>5</td>
<td>G5</td>
<td>To test ESJ application combined with fat graft injection into ESJ and burying it into adjacent muscle is more effective than ESJ application alone.</td>
</tr>
<tr>
<td>6</td>
<td>G6</td>
<td>To test the effect of neurona formation and setting.</td>
</tr>
</tbody>
</table>

Sciatic nerve was dissected and 2 cm segment of the nerve was resected. Nerve fascicles were removed using pull out technique. Creating an empty epineural sheath conduit. The distal part of the conduit was closed and proximal part was trimmed creating 7 mm long tube of protective ESJ. Finally, ESJ was applied over the proximal nerve stump using epineural sleeve technique (Groups 1-4). In Groups 3 and 4, ESJ application, autologous fat was harvested from the gluteal region and following appropriate fat processing, it was injected into ESJ. Animals were evaluated at 12 weeks and 24 weeks follow-up.

Animals were euthanized and samples of the proximal stump were harvested for Masson trichrome, Toluidine blue and S-100 staining.

**Results**

**Sciatric nerve stained with Toluidine blue.** (Left) G1 group (stump without any protection): disorganised structure of the nerve. (Center) G2 group (stump burried into muscle): more organised nerve architecture with dispersed axons on the nerve periphery but less amount of connective tissue compared with Group 5. (Right) G6 group (stump protected with ESJ): normal nerve architecture with regular neural-to-connective tissue ratio. Magnification x100.

**Neural-to-connective tissue ratio.** For nerves protected with ESJ (Group 1 and ESJ burried into muscle (Group 2) compared with nerves without any protection (Group5). Note the comparable results for ESJ and ESJ burried into muscle with current gold standard in neurona management – muscle burrying into muscle.

**Conclusions**

- We confirmed the feasibility of ESJ application as a new method for prevention of neurona formation.
- The ESJ integrity and structure was preserved in Groups 1 – 4.
- Neural-to-connective tissue ratio demonstrated with Masson trichrome staining in Group 1 and 2 was comparable with the current gold standard in neurona treatment – muscle burrying.
- Due to S-100 staining, nerve architecture was maintained in groups with ESJ protection, whereas in Groups 5 and 6 disorganization of the nerve fascicles was noticed.
- Nerve stump protected with ESJ stained with Toluidine blue showed more organized, regular pattern of nerve fibres with less amount of connective tissue stroma.
- The ESJ prevented neurona formation.
- The ESJ is promising new technique in neurona management.

**Figure 1.** Preparation and application of the Epineural Sheath Jacket (ESJ). (Above Left) A 2 cm long nerve segment resection of the sciatic nerve. (Above Right) Nerve fascicles removal using pull out technique. (Below Left and Right) ESJ application over proximal nerve stump.

**Figure 2.** The neural-to-connective tissue ratio was increased for nerves protected with ESJ (Group 1) and ESJ burried into muscle (Group 2) compared with nerves without any protection (Group5). Note the comparable results for ESJ and ESJ burried into muscle with current gold standard in neurona management – muscle burrying into muscle.