ADHESIVE SEALANT BIOMATERIALS

Clinical Series

David Mandley PhD
Tissuemed Ltd.

Use of TissuePatchDural™ in a Porcine Dural Repair Model

Introduction

One of the most challenging complications of cranial surgery is leakage of cerebrospinal fluid (CSF). Despite advances in neurosurgical techniques and the development of adjunctive methods to repair dural defects, the incidence of postoperative CSF leakage remains high. Current methods such as fibrin sealants (used alone or in combination with surgical meshes), haemostatic agents, polyethylene glycol based gels and other preparations are not a quick or complete solution.

TissuePatchDural - the latest member of the TissuePatch3 product family is CE mark approved and has been designed to offer the surgeon effective sealing of the Dura Mater (Dura) in a user-friendly presentation with clinically advantageous characteristics including low material bulk, rapid delivery to the target tissues, zero preparation time and very short application time. TissuePatchDural is a sterile, absorbable surgical 40µm film comprising alternate barrier layers of poly(lactide-co-glycolide) and an adhesive and sealant poly(N-vinyl-pyrrolidone-co-acrylic acid-co-*N*-hydroxysuccinimide ester of acrylic acid) terpolymer, with a methylene blue visualisation aid, and is absorbed in about 50 days. This study characterises the performance of TissuePatchDural from a preclinical perspective.

Methods

A total of six porcine subjects were included in this study. For each subject a "V" shaped skin incision was made caudo-cranially to expose the skull on both sides of the midline. On each side of the midline a craniotomy 2.0x2.0cm was created and the resultant squares of cranium removed and retained sterile. A piece of dura ≈ 0.7x1.5cm was incised and elevated along three sides of a square. The right hand side defect (control) was sutured via a series (typically n=6) of interrupted sutures (7/0 Mersilk). The left hand side defect was sutured in an equivalent manner to the control side, followed by application of a section of TissuePatchDural.

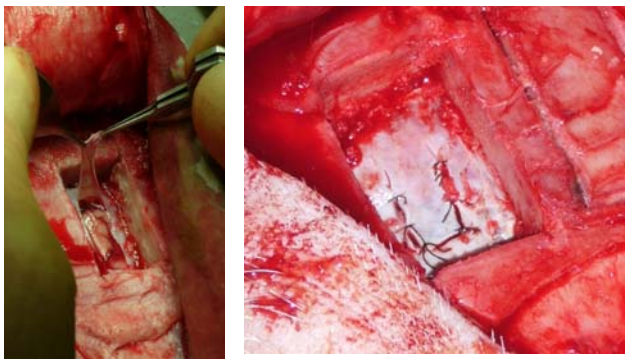

Figure 1 Creation of Dural Defect and sutured durotomy

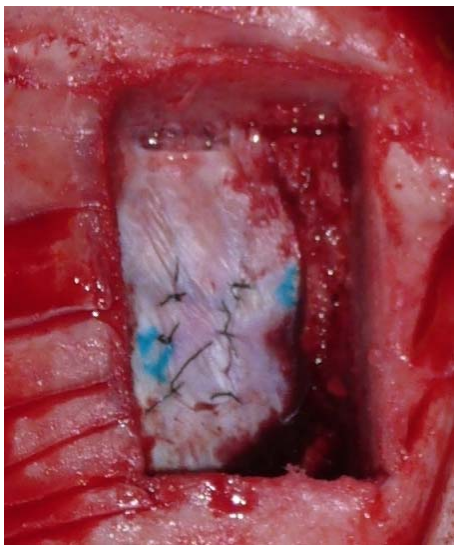

Figure 2 Sutured Durotomy followed by TissuePatchDural application

Results

Acutely, of the six 'suture only' control sites, two required additional intervention to treat CSF leaks. This involved application of TissuePatchDural. Of the four remaining control 'suture only' sites, three displayed mild CSF leakage not requiring treatment, whilst one was free of CSF leaks. TissuePatchDural was 100% effective at preventing CSF losses from previously sutured dural defects. At both recovery time points, 14 and 28 days all animals remained neurologically intact with no reported changes in their health or behaviour. Examination of all sites revealed that all dural defects were sealed with no evidence of post operative fluid loss. Macroscopically, the tissues were normal with some discolouration to the dural tissue. For the durotomy sites treated with TissuePatchDural the remains of the patch after 28 days were visualised as degrading transparent gel.

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Qualitatively (by appearance and manipulation) the 'suture only' sites were reported as slightly more fibrosed (thicker) when compared to the 'suture + TissuePatchDural' treated durotomies. There were no other remarkable features evident during the course of the macroscopic examination.

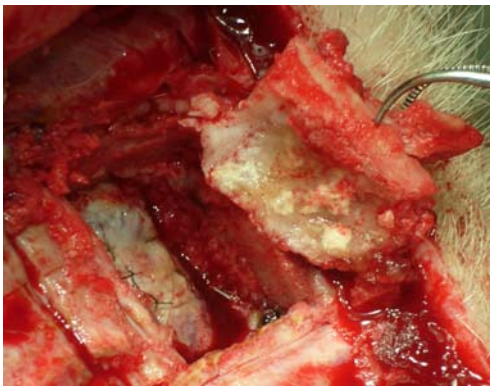

Figure 3 TissuePatchDural Durotomy site – 28 days

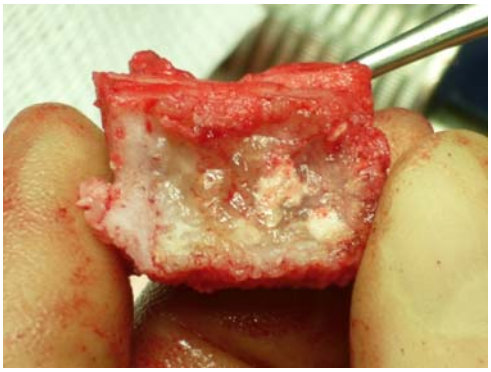

Figure 4 Degraded TissuePatchDural on underside of Craniotomy

Histologically, where TissuePatchDural was applied, the sealant was clearly seen (at both time points) in place secured on top of the external surface of the dura where originally applied and forming an effective seal. The tissue response to TissuePatchDural, is a minimal inflammatory response and is localised immediately adjacent to the remaining material. Furthermore, this response, is less than the significant inflammatory (acute and chronic) response to the sutures used as the primary means of closure of the dura.

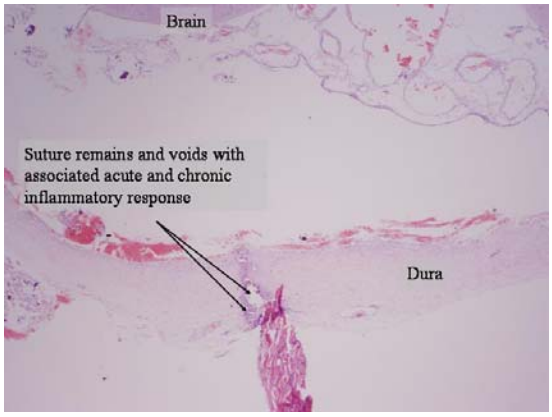

Figure 5 Histology of "Suture only" control Durotomy

The minimal inflammatory response to TissuePatchDural consisted of polymorphs, a few monocytes, some macrophages and the very occasion giant cell. With the exception of one durotomy, in which there was pre-existing damage to the brain, the brain beneath the TissuePatchDural-treated Dura displayed minimal changes and there was no evidence of damage to the underlying brain adjacent to or remote from the dural repair.

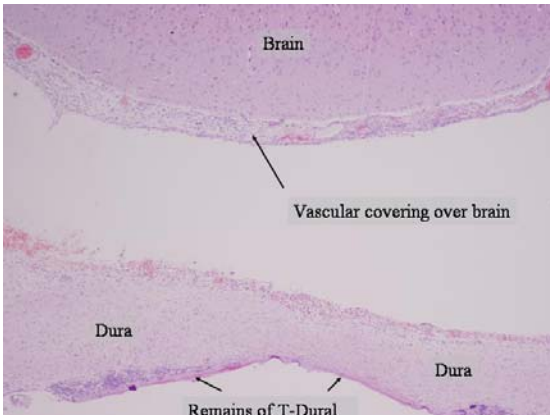

Figure 6 Histology (x40) showing remains of TissuePatchDural closely adhered to Dura at 28 days

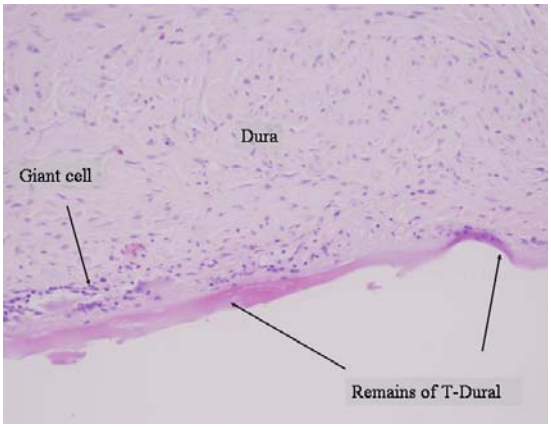

Figure 7 Histology (x200) showing remains of TissuePatcDural closely adhered to Dura at 28 days

Conclusion

The results from this *in vivo* study indicate that TissuePatchDural is safe and effective and has potential to provide a useful adjunct in the reduction of CSF leaks during and after neurosurgical procedures.

Intraoperatively the product performed well, sealing all leaks in these loosely sutured Durotomies. At 14 and 28 days all dural defects remained sealed with no evidence of leakage, and patch remains suggested degradation was occurring at the anticipated and clinically relevant rate. Histological sections showed good conformance and sealing to tissue surface with predictable foreign body response.

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