ADHESIVE SEALANT BIOMATERIALS

Technical Bulletin

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In vitro performance of TissuePatchDural™ compared with DuraSeal™

Summary

This paper investigates two performance related aspects of the TissuePatch products (note that with respect to these performance criteria TissuePatch3 and TissuePatchDural should be considered analogous) in comparison with the most commonly used liquid sealant DuraSeal. The key performance criteria assessed *in vitro* are adhesion and burst pressure.

Adhesion was assessed using a method developed in-house incorporating the use of the market leading dural substitute Duragen (Integra Neurosciences). Porcine liver was used as the test substrate, with a Zwick Universal Testing Machine being used to remove each test sample from the surface.

Burst pressure was assessed according to the guidance provided within ASTM method F 2392-04 Standard Test Method for Burst Strength of Surgical Sealants.

The adhesion of TissuePatchDural when used in conjunction with DuraGen was shown to be significantly greater than that of DuraSeal.

Burst pressure of TissuePatch3 was demonstrated to be statistically comparable to the burst pressure of DuraSeal in the model used.

Background

DuraGen is used to treat dural defects following cranial and spinal surgical procedures. Both DuraSeal and TissuePatchDural can be used adjunctively to provide a watertight seal and thereby prevent Cerebrospinal Fluid leakage, a recognised cause of post-operative complications often requiring additional surgery.

It is proposed that TissuePatchDural could be used in conjunction with DuraGen during the treatment of dural defects and it is the adhesive characteristic of the two sealant products in combination with Duragen that is assessed here in an *in vitro* model.

The secondary aim of this study was to compare the *in vitro* burst pressure of TissuePatch3/TissuePatchDural with that of DuraSeal.

Methods

Adhesion study

A 1 x 1 cm sample of DuraGen was prepared. This was secured to a 7 x 7 mm foil stub using superglue, with the smooth side of DuraGen being exposed. The DuraGen sample was moistened using a spray of DPBS before being gently placed on a slab of fresh porcine liver.

A slit (~7 mm wide) had previously been inserted, using a scalpel, into a 2.5 x 2.5 cm section of TissuePatchDural (TD-005-08). This TissuePatchDural sample was carefully placed over the DuraGen sample and pressed firmly onto the liver for 10 seconds before being left for 5 minutes (Figure 1).

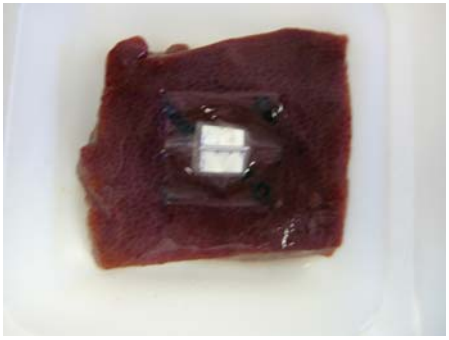

Figure 1 TissuePatchDural laid over DuraGen sample and adhered to porcine liver

The sample was then submerged in a dilute human albumin solution for a further 5 minutes before being tested for adhesion using a Zwick Universal Testing Machine (Figure 2).

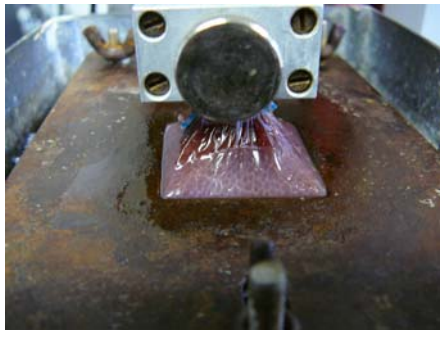

Figure 2 Adhesion testing of TissuePatchDural overlaid on DuraGen

For analysis of DuraSeal, DuraGen samples were prepared and placed on a slab of porcine liver in an identical manner.

DuraSeal was prepared in accordance with the manufacturer's instructions and applied over the DuraGen sample. DuraSeal was applied with an approximate 1 cm margin around the DuraGen sample (Figure 3). The DuraSeal was approximately 2 mm thick.

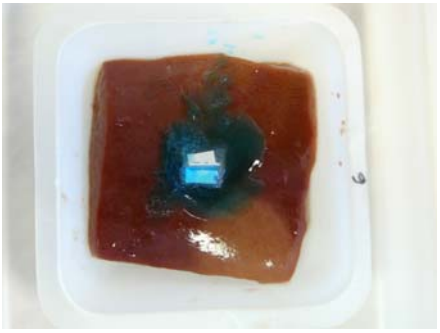

Figure 3 DuraSeal applied over DuraGen and adhered to porcine liver

Following application, DuraSeal was left for 5 minutes. The samples were then submerged in a dilute albumin solution before being tested for adhesion using a Zwick Universal Testing Machine (Figure 4).

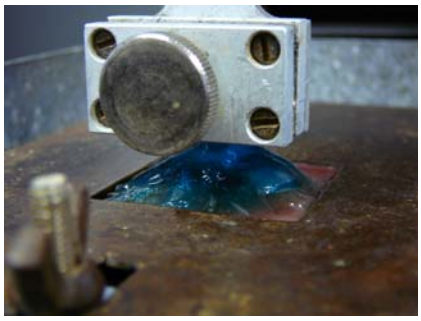

Figure 4 Adhesion testing of DuraSeal applied over DuraGen

Burst pressure study

Burst pressure testing was undertaken in accordance with the guidance provided within ASTM method F 2392-04 Standard Test Method for Burst Strength of Surgical Sealants.

A 4 cm diameter circle of collagen film was washed in distilled water, before being soaked in fresh distilled water for 5 minutes.

The collagen film was removed from solution, placed on a flat surface and patted dry. A hole punch was used to create a 3 mm hole in the centre of the collagen film. An approximate 1 mm thick mould was placed over the collagen film, so that the 15 mm hole of the mould was centrally placed over the 3 mm hole of the collagen film.

DuraSeal was prepared according to the manufacturers instructions. DuraSeal was applied so that the hole of the mould was filled (Figure 5). DuraSeal was then left for 5 minutes before the mould was carefully removed.

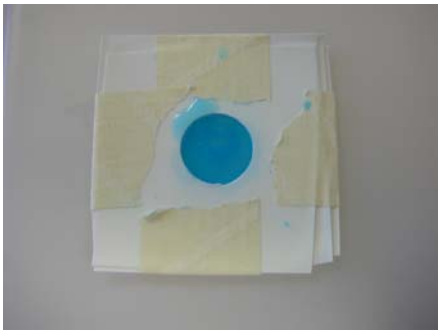

Figure 5 Application of DuraSeal within burst pressure testing mould

The burst pressure experimental set-up is illustrated by Figure 6. Water was allowed to flow through the system prior to testing to remove any air from the system. The tubing at the end of the system was then sealed.

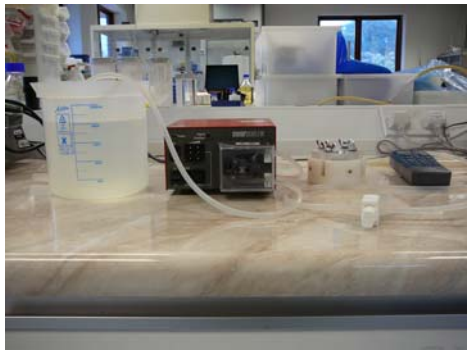

Figure 6 Burst pressure experimental set-up

The collagen film was placed on the base of the burst pressure test rig. The burst pressure test rig top was put into position before being secured with the o-rings and wing nuts.

The pressure gauge was zeroed and the peristaltic pump was switched on at a flow rate of 2 ml/minute.

The procedure employed for burst pressure testing of TissuePatch3 (TP3-008-08) was similar, with a 15 mm diameter sample of TissuePatch3 been applied, by way of 30 seconds of pressure.

Results

Adhesion study

The mean work of adhesion of TissuePatchDural when used in conjunction with DuraGen was 4.249 mJ ± 1.420 mJ (variance = 33.43 %). Failure was due to the stub of DuraGen tearing through the incision of the TissuePatchDural specimen (Figure 7).

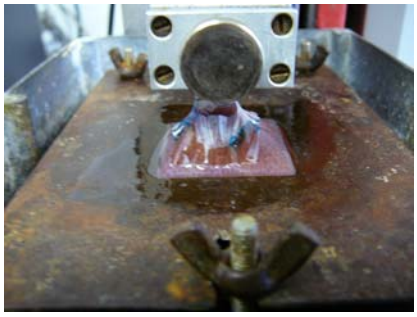

Figure 7 Failure of TissuePatchDural during adhesion testing

The mean work of adhesion of DuraSeal when used in conjunction with DuraGen was 1.765 mJ ± 0.808 mJ (variance = 45.78 %). The majority of the samples failed cohesively (Figure 8).

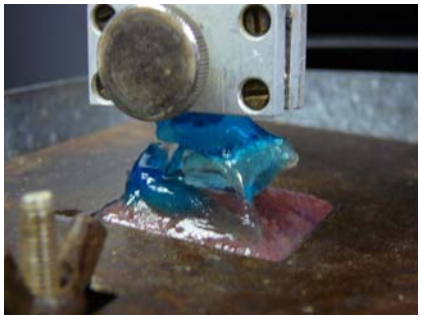

Figure 8 Cohesive failure of DuraSeal during adhesion testing

The mean work of adhesion of DuraSeal was significantly lower than the mean work of adhesion of TissuePatch Dural (t-test, p=0.01).

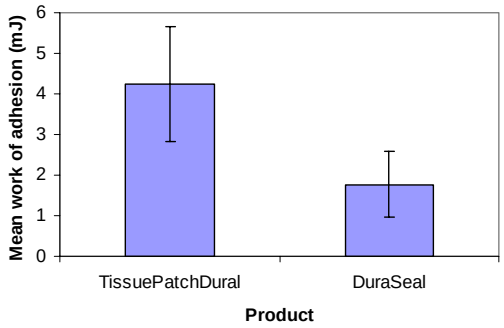

Figure 9 Mean work of adhesion (mJ) of TissuePatchDural and DuraSeal

Burst pressure study

The mean burst pressure of TissuePatch3 was 99.5 mbar ± 58.2 mbar. The mean burst pressure of DuraSeal was 71.4 mbar ± 55.0 mbar.

There was no significant difference between the burst pressure of TissuePatch3 and DuraSeal (t-test, p=0.01).

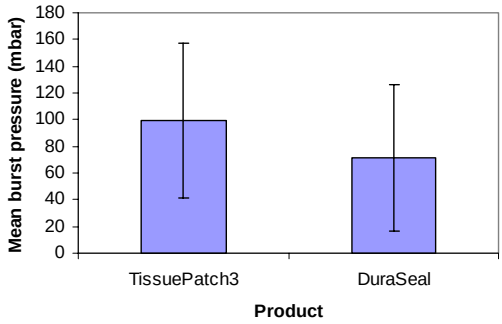

Figure 10 Mean burst pressure (mbar) of TissuePatch3 and DuraSeal

Conclusions

This acute physical performance study suggests TissuePatchDural has the potential to be used in conjunction with DuraGen, with no loss of adhesive function. TissuePatchDural has exhibited superior adhesive properties *in vitro*, when compared with DuraSeal. Notably, without the mounting slit necessary for the test, the likelihood is that the mean work of adhesion would have been greater.

Burst pressure of TissuePatch3 /TissuePatchDural is statistically similar to that of DuraSeal. Notably subsequent additional testing of TissuePatchDural following this study has yielded results with mean values significantly higher than those reported here (mean 140mbar).

If calculated on a per mm thickness basis (commonly used measure) TissuePatchDural would possess burst pressure resistance figures 25 times greater than those presented here, while Duraseal would be roughly 50% of the value reported.

References

Preul, M.C., Bichard, W.D., Campbell, P.K., Garlick, D.S. & Spetzler, R.F. Obtaining Watertight Closures of Duraplasty Onlay Grafts in a Craniotomy Preclinical Model (Confluent Surgical Incorporated white paper)

ASTM method F 2392-04 Standard Test Method for Burst Strength of Surgical Sealants.

Note:DuraSeal is a trademark of Covidien AG

Duragen is a registered trademark of Integra Lifesciences Corp

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