Comparison of Bursting Pressure after Scleral Tunnel Incision Sealed with Sutures or an Adherent Ocular Bandage in Human Globes

EJ Jun1, JH Kim2, TL Purcell3 and DJ Schanzlin3

1Department of Ophthalmology, St Paul’s Hospital, The Catholic University of Korea, Seoul, Korea; 2Department of Ophthalmology, Ilsan Paik Hospital, Inje University of Korea, Goyang, Korea; 3Department of Ophthalmology, Shiley Eye Center, University of California San Diego, La Jolla, California, USA

OBJECTIVE: To evaluate the efficiency of a hydrogel adherent ocular bandage for sealing of scleral tunnel incisions in human eye globes. METHODS: A 4-mm scleral tunnel incision was made in each of 10 globes and bursting pressure was measured using the Seidel test to check for wound leakage. Globes were sealed using either two interrupted 10–0 nylon sutures (n = 5) or an adherent ocular bandage in the form of polyethylene glycol hydrogel (n = 5). Bursting pressure was then measured for a second time. RESULTS: Bursting pressure was significantly higher after wound sealing in both groups. There were no statistically significant differences in bursting pressure between the two groups before or after sealing. CONCLUSIONS: The adherent ocular bandage successfully protected the incision in ex vivo human globes immediately after surgery, with a sealing efficiency comparable to two nylon sutures, suggesting that it is a safe and effective alternative to conventional suturing.

KEY WORDS: ADHESIVE OCULAR BANDAGE; POLYETHYLENE GLYCOL HYDROGEL; BURSTING PRESSURE; SCLERAL TUNNEL INCISION; SCLERAL SUTURE; HUMAN GLOBE

Introduction

Wound sealing after intraocular surgery is very important, particularly in the prevention of endophthalmitis.1–5 Suture application prolongs surgery time and may be associated with astigmatism,6–9 suture erosion,10 inflammation, infection,11,12 neovascularization13,14 and irritation due to suture sensation. Glue is a good alternative that does not have the same complications as sutures, but it has other limitations in a clinical situation. Cyanoacrylate glue produces heat, sets too rapidly, and results in an inflexible and friable material that can cause patient discomfort.15,16 The method of application is cumbersome and can be problematic,17 and tissue fibrin glue carries the theoretical risk of anaphylaxis and disease transmission.18,19

Polyethylene glycol hydrogel is quick and easy to apply and provides a soft, smooth and biocompatible wound seal.20,21 The
adherent ocular bandage is applied to the incision as a liquid that then gels in approximately 30 s and remains localized on the incision. The bandage softens over time, eventually detaching after providing protection throughout the re-epithelialization process, and is sloughed off in the tears. Hydrogel has been shown to be effective for sealing 2.2- and 2.5-mm clear corneal incisions in cataract surgery\textsuperscript{22,23} and in 23-gauge sclerotomy for vitrectomy\textsuperscript{24,25}

The present study evaluated the application of a hydrogel adherent ocular bandage following a 4-mm scleral tunnel incision, such as that normally used for the insertion of Descemet’s stripping endothelial keratoplasty (DSEK) donor tissue.

Materials and methods

PREPARATION OF GLOBES

Research-grade whole globes ($n=10$) were obtained from the San Diego Eye Bank, San Diego, CA, USA. Ethical approval was not required for this study, as all globes were research grade and unsuitable for corneal transplantation. A 4-mm scleral tunnel incision was made in each globe with a crescent knife (Alcon Laboratories, Fort Worth, TX, USA), 1.5 mm behind the posterior limbus superiorly and extending into clear cornea.

The bursting pressure was measured in all globes before wound sealing. The incision was sealed with either: (i) two 10–0 nylon (Black Monofilament; Alcon Laboratories) interrupted sutures ($n=5$); or (ii) an adherent ocular bandage (Resure$^\text{TM}$, Ocular Therapeutix, Bedford, MA, USA) applied according to the manufacturer’s instructions after thorough drying of the wound ($n=5$). After the incision had been sealed by suture or adherent ocular bandage, the bursting pressure was measured for a second time.

BURSTING PRESSURE MEASUREMENT

Balanced salt solution was irrigated into the anterior chamber of the globe. The bottle of solution was then raised slowly and continuously, and wound leakage was monitored using the fluorescein-based Seidel test (Fig. 1). The height of the bottle above the incision when leakage was first noted was measured and the intraocular pressure converted from cm H\textsubscript{2}O to mm Hg ($1\text{ mm Hg} = 1.36\text{ cm H}_{2}\text{O}$). The maximum attainable intraocular pressure was 145 cm H\textsubscript{2}O, which is equivalent to 106.66 mm Hg.

STATISTICAL ANALYSES

Data are presented as mean ± SD. Within-

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**FIGURE 1:** Seidel test for leakage following increased pressure in human globes with a 4-mm scleral tunnel incision. Leakage is indicated by pale areas on the fluorescein-stained globes (triangles and arrows). (A) Before sealing. (B) After sealing with sutures. (C) After sealing with polyethylene glycol hydrogel adherent ocular bandage.
group comparisons of bursting pressure were made using the Wilcoxon signed-rank test and between-group comparisons were made using the Mann–Whitney U-test. Statistical analyses were performed using SPSS® version 16.0 (SPSS Inc., Chicago, IL, USA) for Windows®. A P-value < 0.05 was considered to be statistically significant.

Results
Mean bursting pressures in the two groups before and after the wound was sealed are given in Table 1. The bursting pressure was significantly increased after sealing with either sutures (P = 0.043) or adherent ocular bandage (P = 0.043).

There were no statistically significant differences in bursting pressure between the two groups before or after sealing (Table 1). Sutures increased bursting pressure by 70.69 ± 25.48%, and application of an adherent ocular bandage increased bursting pressure by 76.09 ± 21.36%. This difference in the change in bursting pressure between the groups was not statistically significant.

Discussion
Tissue adhesives can provide rapid, convenient wound closure and prevent influx of fluid into the eye without the disadvantages associated with sutures.26 The adhesive used in the present study was an elastic hydrogel that is compliant with the underlying tissue and minimizes the risk of causing astigmatism.20 The surface of the hydrogel is smooth and should, therefore, cause little foreign body sensation. It has been shown to be noncytotoxic and not associated with any acute systemic toxic effects.24

A previous study using ocular bandages reported increased incision strength after application to a 2.8-mm clear corneal incision, as used for sutureless cataract surgery, and a 23-gauge scleral incision, as used for sutureless vitrectomy.21 The pressure at which the incisions first leaked was higher following the application of the liquid bandage than when no liquid bandage was used, but no comparison was made with sutures. In the present study, an adherent ocular bandage was applied to a 4-mm scleral incision as normally used for DSEK. It significantly increased the bursting pressure compared with a sutureless wound, with a sealing efficiency that was comparable to

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**TABLE 1:** Bursting pressure of human globes with a 4-mm scleral tunnel incision before and after sealing with sutures (group I) or polyethylene glycol hydrogel adherent ocular bandage (group II)

<table>
<thead>
<tr>
<th>Globe No.</th>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Presealing</td>
<td>Postsuture</td>
</tr>
<tr>
<td>1</td>
<td>46.74</td>
<td>73.82</td>
</tr>
<tr>
<td>2</td>
<td>53.05</td>
<td>74.43</td>
</tr>
<tr>
<td>3</td>
<td>37.64</td>
<td>70.14</td>
</tr>
<tr>
<td>4</td>
<td>35.68</td>
<td>73.32</td>
</tr>
<tr>
<td>5</td>
<td>45.43</td>
<td>74.21</td>
</tr>
</tbody>
</table>

Mean ± SD: 43.71 ± 7.08 73.18 ± 1.75a 41.44 ± 4.64 72.19 ± 1.06a

*P = 0.043 compared with presealing pressure; Wilcoxon signed-rank test.

No statistically significant between-group differences in bursting pressure either pre- or postsealing; Mann–Whitney U-test.
Adherent ocular bandage for scleral incisions

that of two nylon sutures, suggesting that it is a safe and effective alternative to the conventional suturing of such incisions.

Synthetic hydrogel sealants have several advantages over biologic materials. They are easy and quick to prepare and use.\(^{21}\) There is no risk of antigenicity or immune response; they are safe, well-tolerated materials made mostly of water that can remain on the eye for extended periods.

In conclusion, the adherent ocular bandage quickly and effectively closed a scleral wound that was relatively large compared with previous studies.\(^{21} - ^{25}\) The increased bursting pressure after application of the adherent ocular bandage suggests it may be helpful in enhancing wound sealing before natural wound healing occurs and may be particularly useful after surgery involving a large scleral incision such as DSEK.

**Conflicts of interest**
The authors had no conflicts of interest to declare in relation to this article.

• Received for publication 24 November 2011 • Accepted subject to revision 30 November 2011

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**References**


Author’s address for correspondence

**Professor David J Schanzlin**

Department of Ophthalmology, Shiley Eye Center, University of California San Diego, 9415 Campus Point Drive, La Jolla, CA 92093, USA.

E-mail: corneacornea123@gmail.com