The Use of Biological Osteoconductive Adhesive in Fixation of Long Bone Fracture - A Pilot Study

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BACKGROUND

Kryptonite Osteoconductive Adhesive (OA) is a commercial product that is claimed to achieve osseointegration and provide micro-adhesion of organic and inorganic material within the bone [1]. It has been proposed that this will provide a rapid, intimate and resistant inter-fragmentary fracture reduction, without the need for plate immobilization to allow primary bone healing [2]. This proposal needs to be rigorously tested.

No normative standards exist and there is no literature that describes methods to perform this type of testing repeatedly on the same specimen pre- and post-fixation by adhesion. However, an established method to quantify the structural properties of long bones is the three point bending test.

AIM

To investigate the potential of osteoconductive adhesive as a new treatment approach for long bone fracture.

OBJECTIVE

To develop a research protocol for repeated three point bending test on pre- and post-fixation by adhesion.

METHOD

Specimen Preparation

Three saw bones were used to conduct this pilot study. Each end of saw bone was cemented into a steel cubic box with Plaster of Paris (POP). Both boxes were aligned in two orthogonal planes with an alignment jig (Figure 1). POP was allowed to set for 24 hours. The bone specimen was positioned with anterior-posterior alignment for the three-point bending test.

Data Acquisition

A Zwick Roell Z050 materials testing machine was set to load the test specimen at 30mm/min. Stress-strain data were recorded, from which fracture strength and work of fracture were obtained. The fractured specimen was reconstructed with Kryptonite OA. This was mixed (Figure 2) and pasted onto the fractured site 15 minutes after mixing. The fractured specimen was then reassembled and clamped in position. After 24 hours the reconstructed specimen was re-fractured, using the same protocol at the same point of loading (Figure 3). The fracture strength and the work of fracture were again documented and compared with the pre-fixation data. The difference in the pre- and post-fixation were established.

FIGURES

Figure 1: Saw bone preparation.

Figure 2: Components of the Kryptonite OA.

Figure 3: Re-fracture of the test specimen.

Figure 4: Cross-section of the post-fixation specimen where specimen fractured at different point than the original fracture.

Figure 5: No fracture line observed in the OA.

RESULTS

Table 1:

<table>
<thead>
<tr>
<th>Saw Bone</th>
<th>S01</th>
<th>S02</th>
<th>S03</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1 (N)</td>
<td>585.58</td>
<td>506.35</td>
<td>529.12</td>
</tr>
<tr>
<td>F2 (N)</td>
<td>434.64</td>
<td>317.89</td>
<td>418.84</td>
</tr>
<tr>
<td>Difference of F1 &amp; F2*</td>
<td>74.22%</td>
<td>62.78%</td>
<td>79.16%</td>
</tr>
<tr>
<td>W1 (J)</td>
<td>13857.13</td>
<td>10832.82</td>
<td>11851.36</td>
</tr>
<tr>
<td>W2 (J)</td>
<td>3948.14</td>
<td>2184.30</td>
<td>4327.44</td>
</tr>
<tr>
<td>Difference of W1 &amp; W2**</td>
<td>28.49%</td>
<td>20.16%</td>
<td>36.51%</td>
</tr>
</tbody>
</table>

F1 – Original fracture strength
F2 – Post-fixation fracture strength
W1 – Original work of fracture
W2 – Post-fixation work of fracture
*100 - [(F1-F2)/F1 x 100]
**100 – [(W1-W2)/W1 x 100]

DISCUSSION

The combination of POP in steel cubic boxes was an effective means of restraining test specimens during pre- and post-fixation loading cycles. Accurate alignment was also readily achieved with the method described. One complete test cycle: fracture, fixation by adhesion and re-fracture was possible in 48 hours by this relatively simple and reproducible procedure.

The adhesive properties of the OA on saw bones were astounding (Figure 4, Figure 5 and Table 1). However, the material properties of saw bones are completely different to human bone. Thus, the results obtained have no relevance to the real clinical situation.

A robust method of testing has been established. Further investigations with fresh animal bones, cadaveric bones and controlled temperature are necessary to determine the effectiveness of Kryptonite OA in fixation of long bone fracture.

CONCLUSION

The protocol developed can be used as standard method in repeated three point bending tests for pre- and post-fixation by adhesion.

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REFERENCES

1. Kryptonite, 2010; Doctors Research Group [online]