**Static Failure Properties of Cable Systems and the Influence of Crimping Position**

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**Introduction:** Cable systems provide a technique to stabilize periprosthetic fractures or prevent crack nucleation or propagation of bone during arthroplasty. Although the designs of these systems are varied, comparative studies on different cable systems have not been well reported. There is a degree of uncertainty over the effect of the position of the crimping device on the failure of cables in vivo. In particular, the effect on the mechanical performance of positioning the crimping device over an angle, such as a bony crest, is unknown. This study examined the static in vitro mechanical performance of different cobalt chrome cable systems using a standard model.

**Materials and Methods:** Five different cable systems were evaluated by static mechanical testing (Table 1).

<table>
<thead>
<tr>
<th>System</th>
<th>Material</th>
<th>Cable design</th>
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<tbody>
<tr>
<td>Accord</td>
<td>SS, CoCr</td>
<td>10/7 bundles</td>
</tr>
<tr>
<td>Cable Ready</td>
<td>SS, CoCr</td>
<td>10/7 bundles</td>
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<tr>
<td>DePuy</td>
<td>SS, CoCr</td>
<td>7x7 bundles</td>
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<tr>
<td>Osteosage</td>
<td>SS, CoCr</td>
<td>7x7 bundles</td>
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<tr>
<td>Control Cable</td>
<td>CoCr</td>
<td>7x7 bundles</td>
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A cable-sleeve construct from each system was embedded in PMMA and sectioned in 2 planes to evaluate the design, cable deformation and the mechanism of fixation. The cables were looped over two 25mm steel rods as outlined in Figure 1.

The cables were tensioned to the maximum tension as read from the instrument gauges, or by "feel" for the instruments without gauges (Stryker and Acumed). The cables were secured by a trained orthopaedic surgeon according to the recommended techniques for each of the different instrument sets. The crimping devices were placed with the long axis either parallel or perpendicular to the applied tensile load (n=4 per system for each orientation). Samples were tested at 37 °C in phosphate buffered saline at 10 mm per minute until failure. The peak load, stiffness and failure mode were recorded for each test. Data was analysed using ANOVA and a Games Howell post hoc testing for unequal variances using SPSS for Windows.

**Results:** Cross sectional analysis of the cables and crimping devices revealed differences between systems. All systems apart from the Accord applied crimping load directly to the cable which resulted in cable deformation. The number and size of the bundles differed between systems (Table 1) and influenced cable deformation within the crimping devices. Three different failure modes were observed and varied between systems as well as with position of the crimping device. Failure due to cable slippage at the crimping device, mid substance cable failure and failure of the cable within the crimping device was found. Isolated failure of a cable bundle that preceded catastrophic failure was found in all systems apart from the Accord which failed due to slippage. Position of the crimping device was an important variable and dictated whether the cable slipped or failed catastrophically as well as the overall load magnitude (range between 3.5 to 6.0 kN). Cable slippage (range 1.0 to 2.0 kN) predominated when the crimping device was parallel to the applied load. Cable failure was the main failure model when the crimping device was perpendicular to the applied load. However, cable slippage was the only mechanism found in the Accord systems. In general, CoCr constructs were superior to SS. The CoCr Cable Ready system (Zimmer) was the stiffest (Figure 2).

**Discussion:** Cable fixation systems provide surgeons with versatility to stabilise implant-bone constructs. The ideal system needs to consider ease of use, versatility and ability to minimise micromotion and allow healing. In vivo failure of cable systems can further complicate revision surgery. An in vitro model was used to examine the effect of material, system design and position of the crimping device on the static properties. Stainless steel and CoCr systems performed similar in the current model. The peak load was greatest when the crimping device was perpendicular to the applied load and cable failure rather than slippage predominated. Position of the crimping device did not significantly influence the stiffness. Cables are composed of fibers formed into bundles that ultimately make up the final construct (Table 1). The 7x7 bundles have "dead" space that allows deformation within the crimping device and influences the mechanical behaviour. The Cable Ready and Accord systems have the same bundle configuration but differ in how the compression is applied and may account for the differences in mechanical properties and slippage. The in vivo loading of cables is unknown and is a limitation of this study.