**INTRODUCTION**

Comminuted distal humerus fractures often require large access to the distal humerus for anatomic reconstruction of the joint surface. In these cases an olecranon osteotomy is usually performed, allowing the triceps muscle to be moved out of the way with clear access to the distal humerus. After fixing the distal humerus, the olecranon is often fixed with two K-wires inserted longitudinally down the ulna and a tension band in a figure of eight, or with a 6.5mm cancellous screw and tension band. These olecranon fixations are commonly associated with complications like K-wire migration, hardware prominence, increased fracture gaps, or non-unions, all requiring secondary operations. Some papers report up to a 70%-80% re-operation rate.

The olecranon osteotomy nail (Figure 1) provides a number of advantages over current fixation methods. First, the nail is drilled for, inserted, and cross-locked in the bone prior to creating the osteotomy at a position distal to the location of the osteotomy. After the distal humerus is fixed, an end cap is simply inserted through the predrilled hole in line with the nail, reducing the olecranon and creating compression across the osteotomy, ensuring an anatomic reduction. This also allows for quick realignment and fixation of the loose fragment, instead of the secondary operation required to fix the olecranon after fixing the distal humerus, saving OR time. Second, the locking holes in the nail are oblique to each other and the anatomic axis of the ulna. This unique design prevents the nail from moving within the medullary canal to prevent toggle and ensure anatomic reduction of the olecranon fragment. Third the locking screws used to lock the nail in place incorporate a threaded head that bites into the near cortex and sits flush with the surface. It also bottoms out on the nail taking up additional clearance between the nail and the screw, preventing toggle of the nail in the canal, and ensuring anatomic reduction. Since the screws sit flush with the surface of the ulna there should be no hardware prominence, and no risk of hardware migration.

**MATERIALS AND METHODS:**

In all cases, a transverse osteotomy was performed through the olecranon approximately at the midpoint between the olecranon tip and the coronoid process of the ulna. The ulna was snapped into a mold and olecranon approximately at the midpoint between the olecranon tip and coronoid process of the ulna. After fixing the distal humerus, the olecranon is often fixed with a delrin block so it can be rigidly clamped during testing. Standard surgical techniques were used to attach the bone model to the delrin block. Four procedures were simulated:

1. K-wire with Tension Band
2. 6.5mm Cancellous Bone Screw with Tension Band
3. Olecranon Nail – Stainless Steel
4. Olecranon Nail – TAN alloy

Test samples were placed in an appropriate test fixture and the proximal end of the olecranon was replaced with a delrin block so it can be rigidly clamped during testing. Two Polhemus electromagnetic sensors were attached to the test samples close to the osteotomy site; one on the delrin olecranon replacement and one on the synthetic ulna bone model. The assembled construct was placed on the test machine and clamped into place creating a 30.5mm moment arm to the fracture site. Once loaded on the test frame, a series of points were digitized along the fracture site. The bone model was then cyclically loaded between 0 and 10N for a total of 10 cycles. Cyclic loading was performed to take out any slack that may have occurred during test sample and fixture assembly. Load was completely removed and the position of the two electro-magnetic sensors was recorded. Load was then applied in 25N increments at a rate of 1mm/min. At each 25N increment, load was held for 5 seconds to allow for reading of the electromagnetic sensors. Loading was continued to a maximum of 1000N or failure of the construct to hold load.

**RESULTS:**

Data was reduced to determine the motion at the fracture site, including:

- Resultant displacement (Figure 2)
- Component displacements (x, y, and z directions)
- Rotational (angular) displacements (about x and z axes).

**DISCUSSION:**

In this study, a new method for treatment of olecranon osteotomies or simple olecranon fractures, use of an olecranon locking nail, is compared with present ‘state-of-the-art’ techniques. The potential advantages of this new technique include reduced OR time, reduced complications experienced with other fixations, especially the K-wire with tension band.

Results of the analyses showed that both the stainless steel olecranon nail and stainless steel screw with tension band have similar displacements and stiffness’s. The TAN olecranon nail shows approximately 40% greater motion, which is consistent with the difference in elastic modulus between TAN and stainless steel. Finally, the K-Wire with tension band option is the least stiff construct and showed notably more motion than all other treatments.

It should be noted that loading of tension band models, was in a ‘best case’ direction, where the tension band is expected to carry a large portion of the bending moment. Loading in other directions or application of torsional loading would not be resisted by the cable (tension band). The olecranon nail systems would be expected to resist this type of loading based upon the geometry of the nail and the cross-locking features.

**Table 1: Initial Stiffness**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stiffness (N/mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olecranon Nail – TAN</td>
<td>707</td>
</tr>
<tr>
<td>Olecranon Nail – SS</td>
<td>1121</td>
</tr>
<tr>
<td>SS Screw with Tension Band</td>
<td>1151</td>
</tr>
<tr>
<td>K-Wire with Tension Band</td>
<td>460</td>
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