Fixation of Olecranon Fractures and Osteotomies Using Compression Screws: A simple Solution to a Common Problem. A Study of Cases

Behrooz Haddad\textsuperscript{1(A,B,D,E,F)}, Wasim Khan\textsuperscript{2(B,E,F),} Ahmed Zaghloul\textsuperscript{1(A,B,D,E,F),} Lisa Grimes\textsuperscript{1(A,B,D,E,F),} Willem Schenk\textsuperscript{1(A,B,D,E,F)}

\textsuperscript{1}West Suffolk Hospital, Hardwick Lane, Bury St Edmunds, Suffolk, United Kingdom
\textsuperscript{2}University College London, Institute of Orthopaedic and Musculoskeletal Sciences, Royal National Orthopaedic Hospital Stanmore Middlesex, United Kingdom

SUMMARY

Olecranon fractures are common skeletal injuries accounting for approximately 10% of upper extremity fractures in adults. Simple non-comminuted fractures are traditionally fixed using the tension band wiring technique. This technique, however, has several complications, most commonly prominence of the metalwork frequently requiring surgery for removal. We describe a retrospective review of a new method of fixation for these fractures using partially threaded screws in an attempt to avoid these complications.

We used two 3.5 and/or 4 mm partially threaded screws to fix seven simple olecranon fractures and two olecranon osteotomies. Notes and clinic letters of all nine patients were reviewed for demographic data, operation details and complications. Radiographs were reviewed at final clinical follow-up. The Mayo Elbow Performance Score was completed during a telephone consultation.

One patient injured her elbow postoperatively, which resulted in fragmentation of the proximal segment and loss of fixation. In one patient the tip of the screws broke after a fall but this did not result in loss of fixation. There were no problems with metalwork prominence or skin irritation in any of the patients. Two patients had low scores due to loss of fixation, and severely comminuted supracondylar fracture of the humerus. Six patients had good scores.

We believe that use of AO compression screws is a valid method for the fixation of simple fractures of the olecranon. It is a safe technique and has several advantages over tension band fixation. There is minimal tissue dissection and operating time is decreased. There is minimal risk of metalwork prominence as screws obtain good purchase in the anterior cortex of ulna. Good interfragmentary compression is achieved as screws are perpendicular to the fracture line and two screws provide good rotational stability. Protection of fixation for 10-14 days does not result in significant loss of range of motion. Further clinical and biomechanical studies are suggested to compare this technique with other methods of fixation of olecranon fractures.

Key words: olecranon, fracture, lag screw, screw, fixation
Olecranon fractures are common skeletal injuries, accounting for approximately 10% of upper extremity fractures in adults [1]. Patients usually present after a fall on the affected arm. Swelling and tenderness is present at the fracture site. With displaced fractures inability to move the forearm against gravity is noted. The Mayo classification is based on whether these fractures are stable or unstable, comminuted or non-comminuted, and displaced or undisplaced [2]. Operative fixation is usually recommended for displaced fractures to restore the function of triceps muscle and allow for smooth movement of the trochlea in the trochlear groove of the olecranon. Type I (undisplaced) fractures with no displacement after 90 degrees of flexion can be treated by splinting and symptomatically. Type II (Non-comminuted displaced stable) fractures are treated surgically. Chevron olecranon osteotomies performed for access to the distal humerus are similar to type II fractures. Several operative methods have been described for surgical treatment of olecranon fractures. Wadsworth [23] originally described the use of a single lag screw perpendicular to the fracture line and gaining purchase in the anterior cortex of the ulna. This method is rarely used nowadays. Currently, these fractures are fixed with tension band wires [4,5,6,7-9,10] or a 6.5-7.3 millimetre AO (Synthes, Switzerland®) cancellous bone screw [11]. Intramedullary nails have also been described for the treatment of olecranon fractures. [12,13,14,15]. Type III (comminuted) fractures are usually treated with plates and screws [16].

Tension band wiring is a commonly used method for fixation of Type II olecranon fractures with no comminution at the articular surface. It was introduced with the aim of earlier post-operative mobilization. It is designed to transform the tensile forces produced by the triceps mechanism to compression forces at the fracture site. To achieve this goal his technique relies on an intact cortex on the articular side. This limits its use for fractures with comminution at the articular (concave) surface. Complications are not uncommon with this technique. Prominent metalwork, skin breakdown and loss of fixation (due to pull out or breakage of the wires) have all been described in the literature [9]. In an attempt to avoid such complications we used a new technique for the fixation of simple non-comminuted fractures.

We describe use of two 3.5 and 4 millimetre cancellous screws which are used to achieve compression across the fracture site in a series of 9 patients (7 fractures and 2 olecranon osteotomies) and discuss the advantages and disadvantages of this technique.
Fig. 1. Preoperative and postoperative AP and lateral views of olecranon fracture fixed with 2 compression screws

Fig. 2. Preoperative and postoperative AP and lateral views of olecranon osteotomy fixed with 3 compression screws
no loss of fixation or prominence of metalwork. Metalwork did not need to be removed in any of the patients.

The summary of cases is presented in Table 1.

**DISCUSSION**

We report nine cases of fixation of olecranon using two compression screws with good and excellent outcomes with only one case of failure of fixation and no need for removal of implants.

**Advantages**

We believe this is a safe technique and has several advantages over fixation by previously described methods. It is a minimally invasive technique and needs minimal tissue dissection. We have used this technique percutaneously in two cases with good outcome. The learning curve is not steep as the steps are very similar to the well-known tension band wiring technique. The surgical time is also decreased using this technique as compared to the tension band wiring technique. The time needed for opening and closure, the assembly of tension band wires and passing the wires underneath the triceps tendon are omitted. The use of two screws provides excellent rotational stability.

**Symptomatic implant**

Rates as high as 46 and 75% of prominent metalwork have been reported with TBW technique [9, 10]. In our series there was no need for removal of the screws in any of the cases. Purchase in the anterior cortex of the olecranon minimises the chance of screw pull-out.

Several methods have been used to solve the problem of prominent metalwork. Van der Linden et al [17] showed the tension band wire technique provides a better stability if the wires are engaged in the anterior cortex of the ulna as compared to the intramedullary position of the wires. Although engaging the screws in the anterior cortex of the olecranon has the potential disadvantage of injuring the volar neurovascular structures in the proximal forearm [18], this risk also exists in the tension band wiring technique. Non-sliding (threaded) pins [8], combined screw and tension bands [7, 19] and long intramedullary wires

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Injury</th>
<th>Mechanism of injury</th>
<th>Operation Date</th>
<th>Medical problems</th>
<th>Complications</th>
<th>LOFU</th>
<th>ROM (degrees)</th>
<th>Mayo Elbow Performance Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27/M</td>
<td>Comminuted # distal humerus</td>
<td>Fall from push bike</td>
<td>ORIF June 2012</td>
<td>Nil</td>
<td>Nil</td>
<td>4</td>
<td>30-100</td>
<td>70*</td>
</tr>
<tr>
<td>2</td>
<td>78/M</td>
<td>Olecranon #</td>
<td>Fall on floor</td>
<td>ORIF June 2012</td>
<td>Prostate Cancer, renal stones</td>
<td>Nil</td>
<td>4</td>
<td>5-130</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>77/M</td>
<td>Olecranon #</td>
<td>Fall on floor</td>
<td>ORIF March 2011</td>
<td>Nil</td>
<td>Nil</td>
<td>18</td>
<td>10-130</td>
<td>95</td>
</tr>
<tr>
<td>4</td>
<td>66/M</td>
<td>Open Olecranon # with some comminution</td>
<td>Motorbike-car accident</td>
<td>ORIF Dec 2011</td>
<td>Nil</td>
<td>Nil</td>
<td>9</td>
<td>5-140</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>79/M</td>
<td>Comminuted # distal humerus</td>
<td>Car accident</td>
<td>ORIF May 2011</td>
<td>IHD and AF on warfarin</td>
<td>Nil</td>
<td>16</td>
<td>5-140</td>
<td>95</td>
</tr>
<tr>
<td>6</td>
<td>30/M</td>
<td>Olecranon #</td>
<td>Fall on floor</td>
<td>Percutaneous Nov 2009</td>
<td>Nil</td>
<td>Nil</td>
<td>12</td>
<td>10-130</td>
<td>85</td>
</tr>
<tr>
<td>7</td>
<td>76/F</td>
<td>Olecranon #</td>
<td>Fall on floor</td>
<td>ORIF June 2012</td>
<td>Nil</td>
<td>Nil</td>
<td>4</td>
<td>20-110</td>
<td>80†</td>
</tr>
<tr>
<td>8</td>
<td>23/M</td>
<td>Olecranon #</td>
<td>Fall playing football</td>
<td>Percutaneous March 2008</td>
<td>AKI, UTI, PE postoperatively treated with warfarin</td>
<td>Fall and loss of reduction 4 weeks postoperatively</td>
<td>54</td>
<td>5-140</td>
<td>100</td>
</tr>
<tr>
<td>9</td>
<td>82/F</td>
<td>Olecranon #</td>
<td>Fall on floor</td>
<td>ORIF May 2011</td>
<td>AKI, UTI, PE postoperatively treated with warfarin</td>
<td>Fall and loss of reduction 4 weeks postoperatively</td>
<td>16</td>
<td>30-120</td>
<td>65‡</td>
</tr>
</tbody>
</table>

LOFU=length of follow up, Shoulder and Hand, M=Male, F=female, NA=not applicable, ORIF, IHD, AF, 
*Patient had high score mainly due to the high energy nature of the injury, no problems with healing of the olecranon osteotomy.
†Patient had concomitant shoulder injury and main disability is due to shoulder pain which is under investigation by a shoulder specialist.
No complaints with regard to the elbow injury.
‡Patient had multiple comorbidities and sustained a fall which resulted in fracture of the proximal segment.
have been used to avoid this complication but still need for removal of 7.7 to 33.3% was reported [6]. FiberWire tension bands in place of metal wire tension bands were used as well to reduce prominence of metalwork postoperatively [4]. Coles et al. [20] used intramedullary screw and supplemental dorsal ulnar wiring and plates and screws for fixation of olecranon osteotomies. They reported 8% rate of symptomatic implant removal. None of our patients had a problem with prominence of metalwork.

Jeopardizing the integrity of the proximal fragment and rehabilitation

The downside of this technique might be increased chance of jeopardizing the integrity of the proximal fragment by inserting two screws in a relatively small fragment. Although one of the patients developed this complication, she had a subsequent injury. In the rest of our patients this did not seem to be a problem if injuries are avoided and gentle progressive rehabilitation is used. The senior author uses back-slabs for protection of fracture fixation with the tension band wiring technique as well. A biomechanical study did not confirm the effect of compression at fracture site and the authors suggested passive range of movement in the postoperative period with tension band wiring as well [11]. Brink et al. [21] showed that tension band wiring principle only exists during active extension in a range of 30-120 degrees of elbow flexion. The protection of fixation for 10-14 days did not affect the final outcome in terms of stiffness and range of movement in our series. We believe that early protection and gentle mobilization provides an acceptable outcome as compared to tension band wiring as excellent range of movement can be achieved and there are no problems with prominence of the hardware. In comparison to a single 6.5 mm screw (which gives a surface area of 33.18 mm²), two 4 mm screws (with cumulative surface area of 25.13 mm²) have a considerably lower surface area and at least theoretically lower chance of jeopardizing the proximal fragment. It is important to avoid inserting the screws too close to each other to avoid this complication. Use of washers also reduces the pressure on the near cortex by increasing the surface area.

Direct fracture compression

Using this technique one can insert the screws perpendicular to the fracture line and achieve excellent interfractional compression. As the fixation does not rely on the compression at the articular surface (unlike the tension band wiring technique), fractures with mild comminution at the fracture site can be fixed reliably with this method. The use of plates and screws is a considerably more invasive procedure and is also associated with prominent metalwork.

We believe that use of AO compression screws is a valid method for the fixation of simple and minimally comminuted fractures of the olecranon. We have also shown that this technique can be used for fixation of olecranon osteotomies for fractures of distal humerus. Further biomechanical and clinical comparative studies are needed to compare this technique with other method of fixation of olecranon fractures.

REFERENCES


