Double tension band osteosynthesis in supra- and transcondylar humeral fractures


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Distal intra-articular bicondylar humeral fractures are usually treated by means of cancellous screw(s) for the condylar block and one or two plates for fixation of the block to the shaft.

The method and results of double tension band osteosynthesis instead of double plating for fixation of the condylar block to the shaft are described here. The advantages of double tension band wiring are an easier and faster procedure, less periosteal and muscle damage, and symmetrical compression. The functional results and complications of patients treated by this method are compared with the results of patients treated with plate fixation.

Introduction

Treatment of intra-articular bicondylar fractures of the distal humerus is difficult. Until 30 years ago treatment consisted of plaster splintage, traction or functional therapy. Poor results were achieved (Krotschek et al., 1973; Gabel et al., 1987; Henley, 1987). In the 1960s a more aggressive approach was gradually adopted, partly under influence of the Arbeitsgemeinschaft für Osteosynthesefragen (AO). By means of rigid internal fixation, an anatomical reduction and early mobilization were obtained. The functional results have improved (as supported by most references in the Reference list). Although several scoring systems were used in the evaluation of functional results, most series produced a figure of ± 80 per cent of operated cases with "good or excellent results" (see Table I).

The fixation technique most often used is that advocated by the AO: reconstruction of the condylar block using a cancellous screw, and fixation of this block to the shaft using two plates. If necessary a spongiosaplasty can be performed. These authors' impression is that, especially in the shaft-to-block fixation, non-union or delayed union occurred frequently. A study of the literature of the last decade revealed a ± 5 per cent incidence of definitive non-union and a 15 per cent incidence of early fixation problems, such as loss of reduction and loosening of material (see Table I).

Double-sided tension band osteosynthesis represents an alternative method of fixation. It carries the theoretical advantages of less devitalization of minor fragments, less muscle damage and better compression. The authors investigated the results of patients who presented with an intra-articular bicondylar fracture in a 5 year period and who were treated by either tension band wiring or plate fixation.

Materials and methods

Between January 1987 and April 1992, 10 patients presented to the University Hospital Maastricht with an intra-articular bicondylar Y-shaped fracture of the distal humer-
Table II. Patient data and results

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age (years)</th>
<th>Classification*</th>
<th>Fixation method*</th>
<th>Operation time (min)</th>
<th>Consolidation (weeks)</th>
<th>Complications*</th>
<th>Range of motion*</th>
<th>Subjective result*</th>
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<td>67</td>
<td>13c:3.2</td>
<td>2 pl (6/6)</td>
<td>180</td>
<td>2</td>
<td>13</td>
<td>Infection</td>
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<td>2</td>
<td>M</td>
<td>69</td>
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<td>2 pl (8/4)</td>
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<td>2</td>
<td>–</td>
<td>Non-union</td>
<td>0–40–130</td>
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<tr>
<td>3</td>
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<td>49</td>
<td>c2:2</td>
<td>1 pl (10)</td>
<td>180</td>
<td>4</td>
<td>13</td>
<td>–</td>
<td>0–10–150</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>16</td>
<td>c2:1</td>
<td>1 pl (7)</td>
<td>240</td>
<td>2</td>
<td>9</td>
<td>–</td>
<td>0–20–110</td>
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<td>F</td>
<td>77</td>
<td>c3:2</td>
<td>2 pl (7/5)</td>
<td>180</td>
<td>2</td>
<td>10</td>
<td>–</td>
<td>0–20–110</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
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<td></td>
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Average 55 years; (average operation time 184 minutes; average consolidation 11.25 weeks.

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<th>Patient</th>
<th>Sex</th>
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<th>Classification*</th>
<th>Fixation method*</th>
<th>Operation time (min)</th>
<th>Consolidation (weeks)</th>
<th>Complications*</th>
<th>Range of motion*</th>
<th>Subjective result*</th>
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<tr>
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<td>81</td>
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<td>1 TW/1 pl (6)</td>
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<td>63</td>
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<td>2 TW</td>
<td>110</td>
<td>2</td>
<td>8</td>
<td>PTD</td>
<td>0–0–150</td>
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<td>6</td>
<td>–</td>
<td>Non-union</td>
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<tr>
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<td>0–10–120</td>
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Average 61 years; average operation time 177 minutes; average consolidation 11.25 weeks.

Re-osteosyntheses

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<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age (years)</th>
<th>Classification*</th>
<th>Fixation method*</th>
<th>Operation time (min)</th>
<th>Consolidation (weeks)</th>
<th>Complications*</th>
<th>Range of motion*</th>
<th>Subjective result*</th>
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<td>c2:2</td>
<td>2 TW</td>
<td>150</td>
<td>0</td>
<td>13</td>
<td>PRNP</td>
<td>0–20–150</td>
</tr>
<tr>
<td>9b</td>
<td>F</td>
<td>27</td>
<td>c2:2</td>
<td>1 pl (8)</td>
<td>240</td>
<td>0</td>
<td>13</td>
<td>TRNP</td>
<td>0–10–130</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</table>

Average operation time 195 minutes; average consolidation 13 weeks

*Fracture classification according to AO (Mueller et al., 1991); †One or two cancellous screws were always used to reconstruct the condylar block; in patients 2b and 9b (re-operations after 4 months) autologous bone graft was added; (pl = plates, TW = tension wire; hole length of the plates used is given in parentheses); ‡PAO = peri-articular calcification, PTD = post-traumatic dystrophy, PRNP = permanent radial nerve palsy, TRNP = temporary radial nerve palsy; °range of motion according to AMA guidelines (1988) (O = neutral position (full extension); normal range 0–0–150, figures indicate, respectively, neutral position – maximal extension – maximal flexion); †p = poor, f = fair, g = good, e = excellent.

Figure 1. Positioning of the patient. A bloodless field is not used. Bilateral incisions to allow for an olecranon osteotomy are made if necessary.

treated primarily with double tension band wiring and five patients primarily with plating.

Patient data are summarized in Table II. Age, sex and fracture classification were similar in the two groups.

Upon operation all patients were placed in a lateral position with the injured humerus on a rest, the forearm hanging down (see Figure 1). A bloodless field was not used.

Medial and lateral incisions (ulnar and radial) were made, distally interconnected at the ulnar ridge to allow for an olecranon osteotomy (see Figure 1). In this way a perfect view of the humeral articular surface was obtained. In both groups the condylar block was reconstructed first using one 6.0 mm or two 4.00 mm cancellous screws, or sometimes one cancellous screw and one K-wire. In the 'plated group', 3.5 mm dynamic compression plates of varying
length were applied. In the 'tension band' group the K-wires which were used to provide a temporary fixation of the block to the shaft were incorporated in a tension band wire at the ulnar and radial side. Proximally, small 2.0 mm holes were drilled, through which to pass the wire. All olecranon osteotomies were fixed by tension band wiring as well. In each case a suction drain was used for 24 h.

All osteosyntheses were considered to be stable at operation, and no additional immobilization was considered necessary. However, postoperatively the elbow was immobilized for 2 weeks in six patients for wound healing purposes. Additional immobilization was given in two patients because of persistent swelling and a hematoma, with a subsequent delayed skin healing.

All patients were re-examined after an average time of 2.5 years (range 0.5-5.5 years) and were asked for a subjective assessment of the result.

Results

In both groups one case of non-union occurred after 4 months. Treatment consisted of tension band wiring in the case of a failed plate osteosynthesis and plate fixation in the other, leaving 12 cases for evaluation. The final results are listed in Table II.

Excluding the two cases of non-union, the average time of consolidation in both groups was 11.25 weeks. After both re-osteosyntheses (including cancellous bone grafting) consolidation took slightly longer (13 weeks).

Both re-osteosyntheses resulted in a radial nerve palsy, one temporary and the other permanent. Exploration in the latter case revealed an irreparable transection.

One superficial infection was seen, and was treated with open drainage. After this procedure healing was uneventful. One patient developed a post-traumatic dystrophy, which resolved completely after 6 months with adequate physical therapy. In one case peri-articular calcification occurred, with a slight restriction of range of motion. This patient, however, suffered no pain, and was completely satisfied.

The range of motion in both groups was the same. Five patients judged their results as excellent and four as good; one patient considered the outcome to be poor because of a flexion deficit of 40°, loss of power and inability to continue his job in construction.

At the patients' request the osteosynthesis material was removed in six cases, after which no deterioration of function occurred.

Figure 3. a, Y-type fracture (13c3.2) in a 61-year-old patient; b, tension band wiring is possible after reduction of the complex fracture to two fragments. The condylar block is reconstructed using two cancellous screws; a loose fragment is fixed to the shaft using a lag screw. The double tension band is then applied. The tension wire is elevated from the bone surface, demonstrating optimal compression at the fracture site.
Discussion

Bicondylar intra-articular fractures of the distal humerus are difficult to treat and form a challenge to surgeons performing osteosyntheses. However, operative treatment leads to better functional results (as supported by most references in the Reference list). As these procedures take several hours, a bloodless field cannot be used. The most important complications of operation are iatrogenic nerve injury (mostly reversible), infection and periarticular ossification. Furthermore, breakage of implants may occur. Almost all studies report a number of mechanical complications, such as loosening or breakage of material and partial loss of reduction, often resulting in non-union. One contributory factor may be that few surgeons have the opportunity to attain enough experience with this rather rare complex fracture. A second factor is the thin cortical bone. In most reports a full description of the material used for internal fixation is absent. It should be noted that double plating appears to be superior to single plating or to the use of screws and Kirschner wires alone (Gabel et al., 1987; Feil et al., 1988; Helfet and Hotchkiss, 1990; Sodergard et al., 1992). Both the AO manual (Mueller et al., 1991) and Schatzker and Tile (1987) advise the use of double plates in Y-shaped fractures.

The authors have described double tension band wiring as a method of internal fixation. This has scarcely been reported (Noack et al., 1987). The method was originally developed by the second author (Bongers, in press) and applied in the authors’ clinic. The results were evaluated in a relatively homogeneous group, and compared with patients treated with plates. No important differences were found. The advantages of the method are an easier and faster procedure — as only K-wires need to be used, and these are already present for initial fixation (Figure 2) — and less damage to muscle and periosteum. Finally, it is much easier to achieve symmetrical interfragmentary compression with tension band wiring than with plating (Figure 3). It is not recommended for severely comminuted fractures since the cortices lack support for compression. In the authors’ opinion, double plating including a bone graft is necessary in such cases. Osteoporosis presents a problem in either method, but, as can be seen from the figures, acceptable results can be obtained. After mechanical failure one should not hesitate to perform re-osteosynthesis (Figure 4), since the results are better compared with conservative treatment (Holdsworth and Mossad, 1990; Kinzi and Fleischmann, 1991). Although nerve injury is reported to occur more often after re-osteosyntheses (Feil et al., 1988), Sodergard et al. (1992) showed that even re-osteosynthesis may yield good results. The present report seems to confirm this statement. In the authors’ opinion, tension band wiring is also a good choice in cases of re-osteosynthesis.

Conclusion

Operative treatment of intra-articular bicondylar fractures of the distal humerus and reosteosynthesis after mechanical failure and non-union lead to a satisfactory functional result. Tension band wiring offers an easy and equivalent alternative to dual plating in such cases.

References


Figure 4 a. Y-fracture (13-3.2) and b. re-osteosynthesis of a non-union with tension band wiring in a 69-year-old patient. In this case a cancellous bone graft was added. This resulted in a permanent radial nerve palsy but otherwise the functional result was good (0–20–150).


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