External Fixation of the Fracture of the Humerus
A Review of 164 Cases

M. Hinsenkamp*
F. Burny*
Y. Andrianne*
J. Quintin*
C. Rasquin*
M. Donkerwolcke*
A.A. Picchio‡
G. Asche§

ABSTRACT: During our experience with external fixation for the fractures of the shaft of the humerus since 1967, the indications have been extended to include complex metaphyseal and epiphyseal fractures of both the proximal and the distal part of the bone. We propose elastic fixation of the fragments using half frame Hoffmann external fixation. Because of anatomical considerations, the two proximal pins must be inserted laterally in the upper third of the humerus, and the two distal pins in the posterior aspect of the lower third above the olecranon fossa. If the mechanical properties of the bone are poor (due to osteoporosis) more than two pins must be used in each fragment. The advantages of the technique include fast and easy application requiring simple materials; versatility of use for fractures at different levels; possible closed reduction, as in conservative treatments; early rehabilitation of joint function; fast periosteal callus formation; and retrieval of the fixator on an outpatient basis.

The reduction and the immobilization of the fracture by osteotaxis are done in emergency. Closed reduction is performed as in conservative treatments. In cases of important muscular interposition, open reduction is possible. Associated internal fixation was required in 18.4% (unstable or articular fractures). A secondary transient radial palsy is observed in 5% of the patients. Intolerance to the external fixation appears in 5.6% of cases, usually consisting of drainage and redness around the pin tracts. A general evaluation of the results gives 73.9% very good results and 93.6% satisfactory results after rehabilitation.

Introduction

From a review of the literature, it appears that external fixation has very specific indications at the level of the humerus: infected pseudoarthroses, open fractures, and limb replantation and derotation osteotomy. External fixation was used by Lambotte, Boever, Anderson, and Hoffmann to treat simple humeral fractures. We started to use external fixation for the fractures of the shaft of the humerus in 1967. We presented our first results in 62 cases in 1979 and in 100 cases in 1980. The indications were extended to complex metaphyseal and epiphyseal fractures of both the proximal and the distal part of the bone. Our indications are now absolute for all kinds of shaft fractures at any level, open or closed, and for nonunions, infected or not; they are occasional for comminuted fractures of the shoulder or of the elbow.

This study analyzes the results in 164 humeral fractures treated by external fixation in four hospitals.

Principle and Technique of Fixation

We propose elastic fixation of the fragments using half-frame Hoffmann external fixation. The principles of fixa-
tion are presented in Table 1.
The advantages of the technique are:
- fast and easy application requiring simple materials;
- versatility of use for fractures at different levels;
- possible closed reduction as in conservative treatments;
- early rehabilitation of joint function;
- fast periosteal callus formation; and
- retrieval of the fixator on an outpatient basis.

### TABLE 1
**PRINCIPLE OF FIXATION**
- Elastic fixation using half frame.
- Two or three interrupted threaded pins in each fragment.
- Anatomical reduction is recommended but not absolutely necessary.
- Proximal pins: upper third, lateral.
- Distal pins: lower third, posterior.

### TABLE 2
**ANATOMICAL CONSIDERATIONS**
- **Transverse Section: Upper Third of the Humerus.**
  - The pins are inserted laterally through the deltoide muscle, avoiding the circumflex nerve, and the medial nerves and vessels.
- **Transverse Section: Lower Third of the Humerus.**
  - The pins are inserted posteriorly through the triceps avoiding the radial nerve, and the medial vessels and nerves.

### TABLE 3
**SPECIFIC INSTRUMENTATION**
- 1 sharp pointed scalpel
- 1 drill brace with a 4 mm chuck
- 4 interrupted thread pins, 12 cm, diameter 4 mm (B21-120-27)
- 1 guide
- 2 clamps
- 1 T wrench
- 1 set of connecting rods (diameter 8 mm)

### TABLE 4
**STEPS OF THE FIXATION**
- Transverse skin incision (1 cm) before the insertion of each pin.
- Drill in the proximal pins first.
- Drill in the distal pins.
- Fixation of the two clamps.
- Closed reduction.
- Insertion of the connecting rod.
- Locking of the clamps.
- Complete flexion-extension of the elbow to create a space for the pins in the triceps muscle allowing painless postoperative rehabilitation.

### TABLE 5
**POSTOPERATIVE CARE AND FOLLOWUP**
- Control x-ray.
- Dressing: Sterile swabs around the pins until dry.
- Nursing: Cleaning of the pins with isotonic saline solution and alcohol two times a day.
- Length of hospitalization: A few days.
- Every two weeks: Control of the pins and control of the mobility.
- Monthly: X-ray control.
- Retrieval of the fixator: On an outpatient basis without anesthesia.

The surgical procedure is performed under general anesthesia, the patient being in a supine position. The shoulder of the fractured side is in a slightly raised position; the forearm, crossing the chest, is held by an aide. Because of anatomical considerations (Table 2) the two proximal pins must be inserted laterally in the upper third of the humerus, and the two distal pins in the posterior aspect of the lower third above the olecranon fossa (Fig. 1).

For epiphyseal fractures of the shoulder, the proximal anchorage consists of three to five continuous threaded pins in the spine of the scapula (Fig. 2). If the mechanical properties of the bone are poor (due to osteoporosis) more than two pins must be used in each fragment.

The instrumentation and steps of the surgical technique are presented in Tables 3 and 4.

A control x-ray is made after surgery. Pin care consists of application of a sterile bandage every day during the first week. The pins are then left exposed to the open air. Cleaning two times a day with alcohol is recommended. Followup is done on an outpatient basis (Table 5).

### Clinical Study

**Characteristics of the Patients and Fractures**

The age distribution is roughly homogeneous. The incidence of the fracture is equal between men and women (50.6% vs. 49.4%, respectively). In most cases, the shaft is involved (61.3%) (Table 6). Many of the fractures are transverse; some are comminuted or have a butterfly fragment. The left side was involved in 54.9% of the fractures; and 12.9% of the patients had a radial pulse at the time of admission in the emergency department (Table 7, Fig. 3).

### Treatment

When possible the reduction and immobilization of the fracture by osteotaxis are done in the emergency department. Closed reduction is performed as in conservative

### TABLE 6
**FRACTURE CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Cases</th>
<th>Line</th>
<th>Number of Cases</th>
<th>Mechanism</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximal epiphysis</td>
<td>10 (6.2%)</td>
<td>Simple transverse</td>
<td>47 (30.3%)</td>
<td>High energy</td>
<td>93 (58.5%)</td>
</tr>
<tr>
<td>Proximal metaphysis</td>
<td>34 (20.9%)</td>
<td>Simple oblique</td>
<td>15 (9.7%)</td>
<td>Low energy</td>
<td>64 (40.3%)</td>
</tr>
<tr>
<td>Shaft</td>
<td>100 (61.3%)</td>
<td>Simple spiral</td>
<td>35 (22.6%)</td>
<td>Pathologic fracture</td>
<td>2 (1.2%)</td>
</tr>
<tr>
<td>Distal metaphysis</td>
<td>17 (10.4%)</td>
<td>Multifragmentar</td>
<td>52 (33.6%)</td>
<td></td>
<td>159 (100%)</td>
</tr>
<tr>
<td>Distal epiphysis</td>
<td>2 (1.2%)</td>
<td>Segmental</td>
<td>6 (3.8%)</td>
<td></td>
<td>16 (5%)</td>
</tr>
<tr>
<td>Unknown</td>
<td>163 (100%)</td>
<td>Unknown</td>
<td>155 (100%)</td>
<td></td>
<td>164 (100%)</td>
</tr>
</tbody>
</table>

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Fig. 1: Oblique fracture of the right humerus in an 18-year-old patient—excellent result.

Fig. 2A: Comminuted fracture of the proximal humerus in a 74-year-old patient.

Fig. 2B: Closed reduction external fixation bridging the shoulder. Pins implanted in scapular spine and distal humerus for 56 days.

Fig. 2C: Final result: Normal motion of the shoulder; loss of 10° in elbow extension.
Fig. 3A: Open fracture of the humerus and forearm, with ulnar bone defect in a 34-year-old patient. External fixation of the three bones, and, at six weeks, cancellous open grafting of the ulnar defect.

Fig. 3B: Retrieval of the humeral and radial pins at 110 days, of the ulnar pins at 150 days. Significant reduction of function due to nerve and muscle damage.
treatments. In cases of important muscular interposition, open reduction is possible.

Associated internal fixation was required in 18.4% (unstable or articular fractures, Fig. 4). In most cases (95%) no other treatment such as Desault bandage or plaster cast was associated; early mobilization of the shoulder and elbow occurred in 86.8%.

Fixator retrieval was performed on an ambulatory basis without general anesthesia.
TABLE 8
MOBILITY AT THE END OF THE TREATMENT

<table>
<thead>
<tr>
<th>Shoulder</th>
<th>Very Good/Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward Extension</td>
<td>82.9%</td>
</tr>
<tr>
<td>Backward Extension</td>
<td>86.7%</td>
</tr>
<tr>
<td>Abduction</td>
<td>75.3%</td>
</tr>
<tr>
<td>Inner Rotation</td>
<td>77.5%</td>
</tr>
<tr>
<td>Outer Rotation</td>
<td>63.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elbow</th>
<th>Very Good/Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension</td>
<td>94.8%</td>
</tr>
<tr>
<td>Flexion</td>
<td>89.7%</td>
</tr>
<tr>
<td>Prosupination</td>
<td>95.6%</td>
</tr>
</tbody>
</table>

Complications

A secondary transient radial palsy was observed in 5% of the patients.

Intolerance of the external fixator appeared in 5.6% of the cases, usually consisting of drainage and redness around the pin tracts. The relative importance of the soft tissue around the pins increases this complication. If necessary, the treatment for persistent reaction is removal of the pins. This complication happens sometimes at the end of the course of treatment of the fracture.

We recorded 5.1% nonunions, and 3.8% of the patients presented with refractures, which healed in three weeks. Malunion (i.e. displacement greater than 20°) appeared in 3.2% of the cases.

Results

An evaluation of the mobility of the shoulder and elbow at the end of treatment is presented in Table 8. A general evaluation of the results gives 73.8% very good results and 93.6% satisfactory results after rehabilitation.

Discussion

External fixation was applied in a continuous series of fractures, including cases of associated metabolic diseases responsible for a majority of the pseudarthroses.

Many techniques are proposed in the literature for the treatment of fractures of the humerus. From comparison with a review of 921 cases in the literature, it appears that the external fixation gave better results than internal fixation and the same results as conservative orthopedic treatment but allowed faster rehabilitation.

The early rehabilitation and functional recovery of the limb improve the daily living activities of the patients during the course of the fracture healing. While stiffness of the joints and muscle atrophy are usually avoided, in some cases a conflict between pins and muscles could be responsible for some limitation.

Conclusion

Elastic half frame external fixation provides appropriate stabilization for fractures of the humerus and a physiological environment that improves periosteal callus formation.

References