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Complications of surgical treatment of humeral shaft fractures managed with a UHN pin: comparison of antegrade *versus* retrograde insertion

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SUMMARY. *Objective.* To describe the complications associated to the surgical management of humeral shaft fractures with a UHN pin using retrograde *versus* antegrade insertion. *Material and methods.* A retrospective, cross-sectional, descriptive study of 22 patients with a humeral shaft fracture managed with a UHN pin between July 1, 1998 and July 30, 2001. Nine patients underwent antegrade insertion and 13 patients underwent retrograde insertion. Perioperative and late complications with both techniques are assessed. Evaluation parameters include bone healing and functional outcome. *Results.* The highest intraoperative complication rate occurred with the antegrade insertion in 3 cases with added shaft fracture. Four cases (44.4%) with the antegrade approach and 3 cases (23%) with the retrograde approach required a second surgery due to nonunion. One case had a circumflex nerve injury and one case had a radial nerve injury with the retrograde approach. There were no differences in the functional outcome of the two groups. *Conclusions.* The highest complication rate occurred with the antegrade approach. Complications are more likely related to surgical technique failures than to the implant or the approach used.

Key words: humeral fracture, shaft, intramedullary nailing, complications.

RESUMEN. *Objetivo.* Describir las complicaciones asociadas en el manejo quirúrgico de fracturas diafisarias de húmero con clavo UHN, tanto en la vía de inserción retrógrada como anterógrada. *Material y métodos.* Estudio retrospectivo, transversal y descriptivo en 22 pacientes con fractura diafisaria de húmero manejados con clavo UHN en el período comprendido del 1ro. de julio de 1998 al 30 de julio del 2001. En 9 casos se realizó inserción anterógrada y en 13 casos retrógrada. Se valoran las complicaciones transoperatorias y tardías de ambas vías. Se consideran parámetros de evaluación la consolidación y resultados funcionales. *Resultados.* Complicaciones transoperatorias en mayor porcentaje en la vía de inserción anterógrada con 3 casos con fractura diafisaria adicional. Se presentan 4 casos (44.4%) en la vía anterógrada y 3 casos (23%) en la vía retrógrada con un segundo procedimiento quirúrgico al evolucionar con pseudoartrosis. Se presenta un caso con lesión del nervio circunflejo y un caso con lesión del nervio radial en la vía retrógrada. No hay diferencia en los resultados funcionales en ambos grupos. *Conclusiones.* La mayor frecuencia de complicaciones se presenta en la vía de inserción anterógrada. Complicaciones debido probablemente más a fallas en la técnica quirúrgica que al implante o a la vía de inserción utilizada.

Palabras clave: fractura humeral, diafisaria, clavo intramedular, complicaciones.

Introduction

Shaft fractures pose radically different problems when compared with epiphyseal fractures. In fact, the epiphyseal cancellous bone has a well-deserved reputation of healing

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both rapidly and completely. This, however, is not the case with a compact shaft bone. A shaft bone heals through associated complex mechanisms that contribute to source callous formation at the periosteal and endosteal levels. On the other hand, reducing an epiphyseal fracture requires great precision, while treating a shaft fracture involves trying to spare the bone length and axes and avoiding any rotational deviation. Reduction, at all costs, known also as anatomic reduction of a third fragment in a butterfly-wing

or an intermediate comminuted fragmented fracture, is no longer valid.¹⁻³

Humeral shaft fractures account for 1.6% of all fractures managed surgically and account for a common problem that orthopedic surgeons face in their daily practice as a result of increased traumas, usually direct, that result from motor vehicle accidents, industrial facilities, and sports.³

There is a growing social pressure to achieve early function and comfort. External immobilization of any kind is annoying, insufficient and many times ineffective and may delay a surgical intervention that could have been performed immediately. This is the case of young people with occupational or sports problems or obese women with large breasts, for whom conservative treatment means being in agony for weeks and sometimes even months.

The role of internal fixation in the treatment of humeral shaft fractures continues to be controversial. A reason for this is the high complication rate reported in a large number of cases, involving delayed healing and nonunion.⁴

In 1998 Rommens reported a series of 190 cases of fractures managed by UHN retrograde nailing with a 4.2% complication rate consisting of avulsions at the entry site of the nail and the same rate of radial nerve palsy; in both instances recovery was spontaneous; 7.4% presented consolidations problems; elbow and shoulder function was excellent in 89.7% and 88.3% respectively of cases.⁵

In 1998, J. Bloom conducted a comparative study of torsion properties of the UHN versus the Russel-Taylor nail. He found that the Russel-Taylor nail had a greater bending strength, possibly because of the smaller bone-nail interface, while the UHN nail showed a greater torsion strength.⁶

Tapio Flinkkild reported 7 cases of nonunion in 13 patients managed with intramedullary nails in 2000.⁴

Andrew reported in 2001 a case of an antegrade intramedullary nailing of the humerus with heterotopic deltoid ossification.⁷

In a review of the literature between 1985 and 1998, Anthony F. Farragos reported one case of intramedullary nailing with both approaches. He found complications such as shoulder pain, nonunion, iatrogenic fractures, supracondylar fracture, elbow pain, injury to the radial nerve, and infection.⁸

In a comparative study of UHN insertion, J. Blumm concluded that the retrograde technique is more demanding. He reported 3.7% of cases with poor shoulder function with the antegrade insertion and 1.8% with poor elbow function with the retrograde insertion.¹

The Unreamed Humeral Nail may be used for retrograde and antegrade insertion and has multiple blocking possibilities, which provides an excellent fixation. Indications for its use include unstable humeral shaft fractures, nonunions, and fractures of pathological fields are included.

The purpose of this study was to assess the complications in patients treated with this technique by comparing the antegrade and retrograde approaches, to document associated complications with the use of these techniques,

and to prevent and assess the later use of certain techniques involving fewer complications for the patient.

Material and methods

This was a retrospective, cross-sectional and descriptive study. Patients with humeral shaft fractures surgically treated with a UHN nail during the period between July 1, 1998 and July 30, 2001 were reviewed.

Patients of both sexes were included. They had recent humeral shaft fractures and humeral fractures over 16 years old, treated with a UHN nail in the upper limb department.

Patients who did not comply with evaluation and follow-up visits at the upper limb department, patients with multiple fractures, with pathological bone fractures, and patients with an incomplete clinical history were excluded.

Patients were enrolled by means of the surgical charts from the OR files and the clinical and X-ray histories.

The data sheet was used in addition to other sheets to record ranges of motion, which were designed at this hospital and approved by the Research Committee. Information on the personal case history and the outpatient assessment was collected as well on each patient.

The surgical technique, with both antegrade and retrograde approaches, was defined as a stable osteosynthesis with a UHN nail for the humerus. The length and diameter of the nail were determined preoperatively for both approaches. In the antegrade surgical technique the acromion was laterally approached; the deltoid fibers were dissected; the supraspinous tendons were identified; a longitudinal incision was made; a Kirschner nail was inserted with a starting punch to open the medullary cavity; the nail was inserted upon reduction of the fracture site with external maneuvers. Free hand distal blocking under fluoroscopic control and proximal blocking with an insertion arch guide were performed.

With the retrograde technique, the incision was made on the posterior aspect of the elbow at the level of the olecranon fossa with a blunt dissection of the triceps fibers; a hole was drilled 3.2 to 2.5 mm above the upper rim of the olecranon fossa and it was posteriorly expanded with a 3.4 drill in a 30° angle posterior to the tapered drill, to introduce an unreamed humeral nail upon fracture reduction by means of external maneuvers; free hand proximal blocking under fluoroscopic control and distal blocking with an insertion arch guide were performed.

Depending on the kind of fracture and the intraoperative findings, a compression device may be used.

Complications from surgical treatment of humeral fractures managed with a UHN nail were analyzed for assessment purposes.

Evaluation parameters were used as a definite functional clinical outcome. We measured the patient's opinion, painful symptoms, strength, and ranges of motion of the shoulder and elbow of the upper limb involved.

X-ray results were assessed by measuring the time to healing, the nail insertion approach, and the biomechanical principle applied.

Data were organized by distributing simple frequencies. Results such as age and sex were analyzed with centrally oriented trending and scattering. Data will be presented through pie and bar charts.

Functional and clinical outcome was interpreted based on the evaluation sheet with the following score: 61 to 70 points, excellent outcome; 49 to 60 points, good outcome; 37 to 48 points, fair outcome; and 28 to 36 points, poor outcome.

Results

Between July 1998 and July 2001, surgery was performed involving osteosynthesis with a UHN humeral nail in 35 patients for various indications. The main ones included recent fractures with an unstable fracture line, delayed healing, nonunion, and pathological bone. Twenty-two patients met the inclusion criteria. Of these, 9 were treated with the antegrade approach and 13 with the retrograde approach.

The mean follow-up time was 35 months (range: 26 to 48 months) for the antegrade approach, and 40 months (range: 30 to 54 months) for the retrograde approach.

The right humerus was involved in 10 patients (45.5%) and the left humerus was involved in 12 patients (54.5%).

The study group included 17 male patients (77.3%) and 5 females (22.7%).

The overall mean age was 46.4 years (range from 27 to 73 years); mean age was 50.4 (range from 29 to 73 years) for the antegrade approach group, and 46.6 years (range from 27 to 69 years) for the retrograde approach group.



Figure 1. Retrograde nail with a healed posterior cortical bone fracture.

The fracture was located on the mid third in 18 patients (81.8%); in 2 cases (9.1%) on the distal third; and in 2 cases (9.1%) on the proximal third.

The mean time between the injury and surgical management was 10.6 weeks (range from 1.2 to 42 weeks) for the antegrade approach and 4.2 weeks (range from 1.1 to 9.2 weeks) with the retrograde approach.

Nineteen 7.5 mm nails and three 9.5 mm nails were placed with lengths ranging from 190 to 260. The biomechanical principle used was of an internal splint plus support in 19 cases and internal splint and protection in 3 cases.

The use of a compression device was mentioned in 6 (27.2%) cases. The mean operative time was 115 minutes (range from 90 to 150 minutes) for the antegrade approach, and 128 minutes (range from 65 to 280 minutes) for the retrograde approach (*Chart 1*).

Mean blood loss was 155 ml (range from 100 to 300 ml) for the antegrade approach, and 265 ml (range from 100 to 600 ml) for the retrograde approach (*Chart 2*).

Intraoperative complications in this series consisted of six cases (27.3%) requiring open fracture reduction (2 antegrade and 4 retrograde cases).

Among the 9 cases treated with the antegrade approach, in 2 cases (22.2%) there were difficulties in free hand blocking; 3 cases (33%) had an additional shaft fracture requiring external fixation, and one case required external fixation plus cerclage. In one case (11.1%), a false approach with a punch was performed with difficulty in introducing the nail.

Among the 13 cases treated with the retrograde approach, in 2 cases (15.3%) there were difficulties in free hand blocking; one case (7.6%) had a posterior cortical bone fracture not requiring additional treatment: one case (7.6%) had a broken drill bit in the blocking hole although no screw was placed (*Figure 1*).

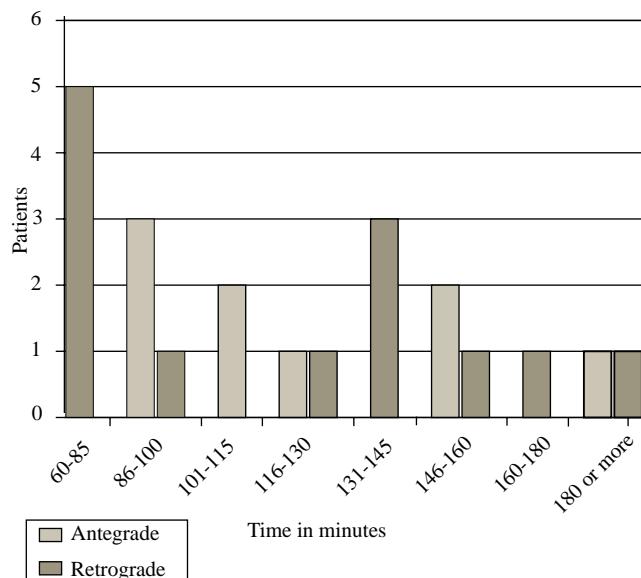
No complications were seen in 4 cases (44.4%) treated with the antegrade approach and in 9 cases (69.2%) with the retrograde approach. Intraoperative complications are presented on *Table 1*.

Five patients had primary healing with the antegrade approach and 10 patients with the retrograde approach (*Table 2*).

Among the late complications, 4 cases (44.4%) required a second surgery for insertion with the antegrade approach. Three cases (33.3%) developed nonunion; two cases required the UHN nail removal and placement of a 4.5 broad DCP plate plus an autologous graft. An additional case required placing the UHN nail again. One case (11.1%) had fracture diastasis and injury of the rotator cuff. The UHN nail had to be replaced and the cuff was repaired (*Table 3*).

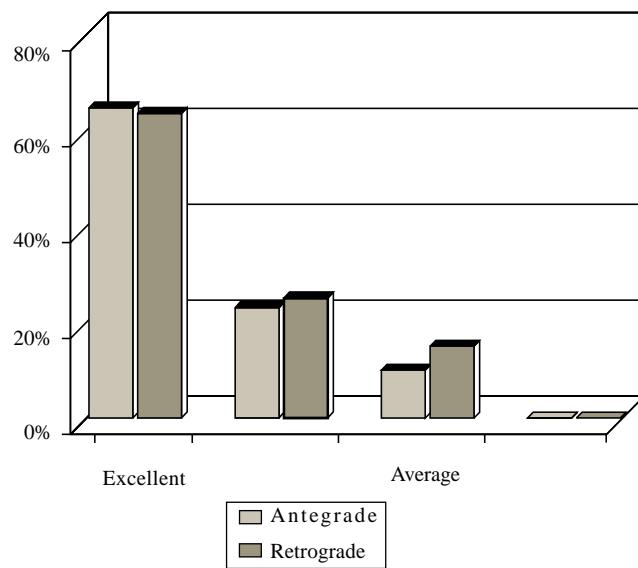
With the retrograde approach, 3 cases (23%) required a second surgery, nonunion developed and removal of the UHN nail was necessary, together with placement of a 4.5 broad DCP plate as well as an autologous graft in 2 of these 3 cases.

One case (7.6%) had injury of the circumflex nerve and one case (7.6%) had axonotmesis of the radial nerve that had already recovered (*Table 3*).



Source: Clinical charts, "Lomas Verdes" Trauma and Orthopedics Hospital.

Chart 1. Operative time.



Source: Clinical files, "Lomas Verdes" Trauma and Orthopedics Hospital.

Chart 3. Functional outcome.

With the retrograde approach, 8 patients (61.5%) had excellent results, 3 patients (23.1%) had good results, and 2 patients (15.4%) had fair results (*Chart 3*).

In spite of the intraoperative complications due to the surgical technique and the late complications, no poor results were reported in this study.

Discussion

Surgical stabilization of humeral shaft fractures has always been controversial, mainly because conservative management has led to excellent outcomes in most patients.

Surgery is indicated for open fractures, associated fractures, vascular injury, nerve injuries, nonunion, multiple fractures, pathological fractures, bilateral fracture, cross-sectional fracture lines, and long spiral fractures. In this study, the main surgical indication was fractures with an unstable fracture line that progressed to nonunion due to failed conservative management.

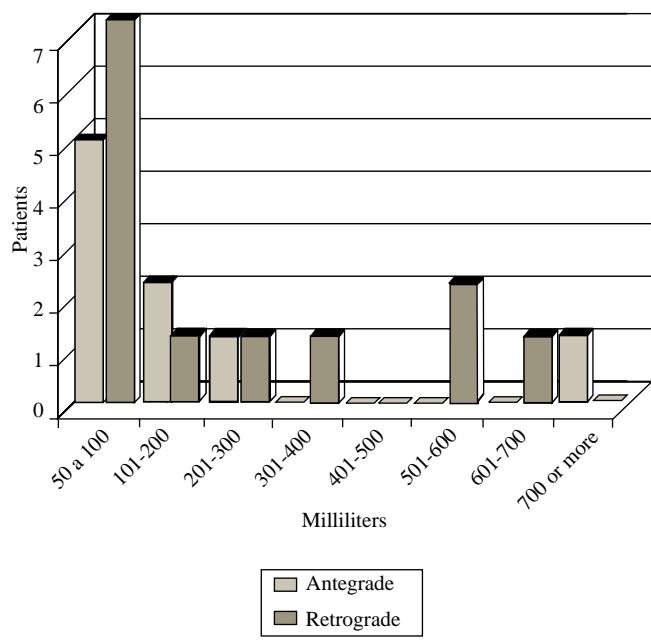
The decision regarding the use of an implant for humeral osteosynthesis is controversial. Some authors report a favorable evolution with low complication rates while other series report mainly treatment-associated complications.

The use of a humeral nail, such as the UHN, is a treatment choice for humeral shaft fractures. It can be used with two insertion approaches, namely antegrade and retrograde.

The nail was designed to prevent the complications found with other osteosynthesis systems such as the use of broad DCP plates and unblocked nails.

Many possibilities for blocking screws and a design for a compressive device are available for use in fractures requiring them.

However, certain case series have reported UHN-associated complications in patients treated surgically.



Source: Clinical files, "Lomas Verdes" Trauma and Orthopedics Hospital.

Chart 2. Blood loss.

No late complications were seen in 13 cases (59%); five of them (55.7%) were operated with the antegrade approach and 8 (61.5%) with the retrograde approach.

Functional results matched the evaluation score used for the antegrade results: 6 patients (66.7%) had excellent results; 2 patients (22.2%) had good results; and one patient (11.1%) had fair results (*Chart 3*).

Table 1. Intraoperative complications.

Complications	Antegrade	Retrograde
Difficult blocking	2	2
Added shaft fracture	3	1
Open reduction	2	4
Drill bit broken	1	0
Difficult insertion	1	0
None	4	9

Source: Clinical files, "Lomas Verdes" Trauma and Orthopedics Hospital.

Table 3. Late complications.

Complications	Antegrade	Retrograde
Nonunion	3	3
Fracture diastasis	1	0
Injury of the rotator cuff	1	0
Injury of the circumflex nerve	0	1
Injury of the radial nerve	0	1

Source: Clinical files, "Lomas Verdes" Trauma and Orthopedics Hospital.

Table 2. Time to Healing (except for patients with a second surgery).

Time	Antegrade	Retrograde
2 months	1	3
3 months	2	2
4 months	0	3
6 months	1	2
Over 12 months	1	0

Source: Clinical files, "Lomas Verdes" Trauma and Orthopedics Hospital.

This study found intraoperative complications such as additional shaft fractures that occurred in 33.3% of cases with the antegrade insertion as compared to the retrograde approach with 15.3%. These results are different from the literature reports, which showing a higher complication rate with the retrograde approach.

Difficult nail insertion and placement of the blocking screws was reported with both approaches.

The radial and circumflex nerves were injured in 5% of cases in some series while in our study this injury occurred in 7.6% of cases, which, however, recovered, with the exception of one case (7.6%) in the retrograde approach group that did not recover from the circumflex nerve injury.

The cases requiring a second surgery for fracture healing purposes represent a significant difference worthwhile being considered. They included 4 cases (44.4%) with the antegrade approach and 3 cases (23%) with the retrograde approach, most of which progressed to nonunion.

In spite of the complications, excellent and good functional results were obtained with both approaches.

The decision as to the type of approach to use resulted from the surgeon's preference. In spite of that, one must consider that the complications in this series were due to technical defects when performing the procedure and could therefore be prevented with a better surgical technique and selecting the approach that involves less complications.

We need to consider that some fractures warrant the use of a compressive device to decrease the incidence of nonunion, which occurred in this series when such a device was

not used. A difference was found in the frequency of intraoperative and late complications, with a higher rate reported with the antegrade approach. Most complications resulted from a defective surgical technique and manipulation by the surgeon. Additional fractures might have been avoided with a proper surgical manipulation. The functional results in both insertion approaches showed no differences. The nerve injury rates similar to those reported in the literature seem to be more closely related to the technical defects at the time of surgery than to the implant or the approach used. We need to consider an insertion approach for this kind of implant providing a lower incidence of complications. To this end, we need to conduct a future follow-up of patients with equal conditions to define what surgical technique provides the highest benefit for the patient.

The mean time elapsed before performing the surgery was very long (an average of 10.6 weeks for the antegrade approach and 4.2 weeks for the retrograde approach). This might have influenced the time to osteosynthesis.

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