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Treatment of Periprosthetic Knee Fractures in the Distal Femur by means of Retrograde Intramedullary Nailing

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Purpose. To assess the radiological and functional results obtained after stabilization of periprosthetic knee fractures in the distal femur by means of a retrograde locked intramedullary nail.
Materials and methods. Retrospective study of 12 patients that sustained a periprosthetic supracondylar distal femoral fracture. Mean follow-up was 14 months (range: 6-24 months).
Results. Clinical and radiological healing was achieved in all patients over a mean period of 15 weeks. As regards complications, the presence of a malunion in 3 out of the 12 patients was probable related the fact that the fracture was not reduced intraoperatively; however, these did not require secondary treatment. Among the possible causes for the periprosthetic fracture, we could mention the existence of an excessive previous femoral osteotomy in five of the 12 patients in our study.
Conclusions. Retrograde intramedullary nailing for the treatment of periprosthetic distal femoral fractures is a technique that has afforded us good results with a low complications rate. The presence of an overly aggressive previous osteotomy that weakened the femoral cortex could be construed to be a likely cause for the periprosthetic fracture; therefore these should be avoided.

Key words: *periprosthetic fracture, intramedullary nail, arthroplasty.*

Tratamiento de las fracturas periprotésicas de rodilla de fémur distal mediante clavo intramedular retrógrado

Objetivos. Valorar nuestros resultados radiológicos y funcionales tras la estabilización de fracturas periprotésicas de rodilla en fémur distal mediante clavo intramedular acerrojado retrógrado.
Material y método. Estudio retrospectivo de 12 pacientes afectados de fractura supracondílea periprotésica de fémur distal. El seguimiento medio fue de 14 meses (6-24 meses).
Resultados. Entre las posibles causas de la fractura periprotésica encontramos la existencia de una osteotomía femoral anterior excesiva en cinco de los doce pacientes de nuestro estudio. Se consiguió la consolidación clínica y radiológica en todos los pacientes, tras un período medio de 15 semanas. Como complicaciones cabe señalar la consolidación en mala posición en 3 de los 12 pacientes por falta de reducción durante la cirugía; ninguna precisó tratamiento secundario.
Conclusiones. La existencia de una osteotomía anterior excesiva que debilita la cortical femoral podría ser una de las causas de fractura periprotésica, por lo que debe ser evitada. El enclavado intramedular retrógrado para el tratamiento de fracturas periprotésicas de fémur distal es una técnica que proporciona buenos resultados con un índice bajo de complicaciones.

Palabras clave: *fractura periprotésica, clavo intramedular, rodilla, artroplastia.*

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The incidence of periprosthetic distal femoral fractures in patients subjected to total knee replacement is low (between 0.3 and 2.5%)[1,2]. Treatment of these types of fractures is problematic. When the prosthetic component is stable there are several options to address the supracondylar fracture without having to act on the femoral component. Different surgical and orthopedic techniques have been described, which afford different results[3].

Table 1. Neer's periprosthetic fracture classification

Neer's supracondylar fracture classification	Type of displacement	Number of patients included in our study (12)
Type 1	Less than 5 mm de displacement or less than 5° angulation	0
Type 2 A	Medial diaphyseal displacement	4
Type 2 B	Lateral diaphyseal displacement	1
Type 3	Compound or significant displacement	7

Treatment of these types of fractures has undergone a significant evolution in the last few years. There are publications that report similar results for surgical and conservative treatment of displaced and/or comminute distal femoral fractures[1]. However, more recent publications report a lower incidence of complications and better functional results for surgical treatment of displaced periprosthetic femoral fractures carried out with intramedullary nailing or anatomic plating using the minimally invasive LISS system (*less invasive stabilization system:* LISS)[3,4].

Among potential complications of this type of fracture, we should mention malunions and post-traumatic stiffness. This means that surgical treatment must try to achieve correct reduction and be followed by early mobilization. Use of the types of implants referred to above makes it possible to obtain appropriate stabilization causing the soft tissues minimal damage.

The purpose of our study is to present our results of addressing periprosthetic distal femoral fractures with retrograde locked nails.

MATERIALS AND METHODS

We present a retrospective study of 12 patients afflicted with a supracondylar periprosthetic femoral fracture sustained further to total knee replacement. Mean follow-up was 14 months (range: 6-24).

Mean age was 76.4 (69-84 years); the series had 11 females and one male. The implant used was cemented in 8 patients and uncemented in 4. Four prostheses were Osteonics (Stryker) and 4 Natural Knee [Zimmer, Indiana, USA]. In all cases, components remained stable at the time of fracture. Knee arthritis had been the primary indication for a knee prosthesis in all our patients. Mean time elapsed from surgery to fracture was 49.2 months (range: 3-216). Two out of the 12 fractures in the study were the result of low-energy trauma, while 2 patients were involved in a car accident.

Neer's classification of distal femoral fractures was used to classify all fractures (table 1). In our series, we found 5 type-2 fractures, 4 of them 2 A and one 2 B, and 7 type 3 fractures.

The surgical technique used was similar in all cases: patient in supine position, flexed knee on a support roll and a medial parapatellar approach to access the intercondylar notch. The fracture was reduced with radioscopic control and stabilized with an reamed M/DN retrograde locked nail [Zimmer, Indiana, USA].

Patients started mobilizing their knee at the second day post-op, as established in the passive and assisted active mobilization program they were put on. Partial weight-bearing was not allowed until the 4^{th}-6^{th} week; full weight bearing was resumed approximately 16 weeks after surgery.

All patients were reviewed clinically and radiologically. Mean follow-up was 14 months. Healing was considered correct when there was radiological evidence of bone fusion with a bony bridge at the fracture site (fig. 1). The study was approved by the Ethical Committee of our hospital.

RESULTS

Among the potential causes for the periprosthetic fractures, the existence o fan excessive anterior femoral osteotomy was suspected. However, it was not possible to establish an accurate measurement of such osteotomies, which were observed in 5 of the 12 patients in our study (fig. 1).

Mean OR time was 105 minutes (range: 55-180) and mean hospital stay was 8 days (range: 6-13). Eight patients required a transfusion during the post-op, with an average 1.6 red blood cell concentrates (standard deviation 0.6).

Both clinical and radiological healing was achieved in all patients in an average 15 weeks (Standard deviation 3.2, range 11-18).

Mean ROM at discharge was 175/110°, with a 180-170° range for extension and 125-95° for flexion.

Three out of the 10 patients suffered malunions (indeed, it was the frequent sequela). Two of these patients healed with a 15° recurvatum deformity, which led to a flexion deficit in excess of 120°); the other one healed with a 10° valgus deformity, probably related to the failure to reduce the fracture intraoperatively, but did not require secondary treatment (fig. 2). None of the patients presented with pseudoarthrosis or delayed healing. We had no deep infections requiring explantation of the hardware. Two patients died during follow-up for reasons unrelated to the purpose of our study.

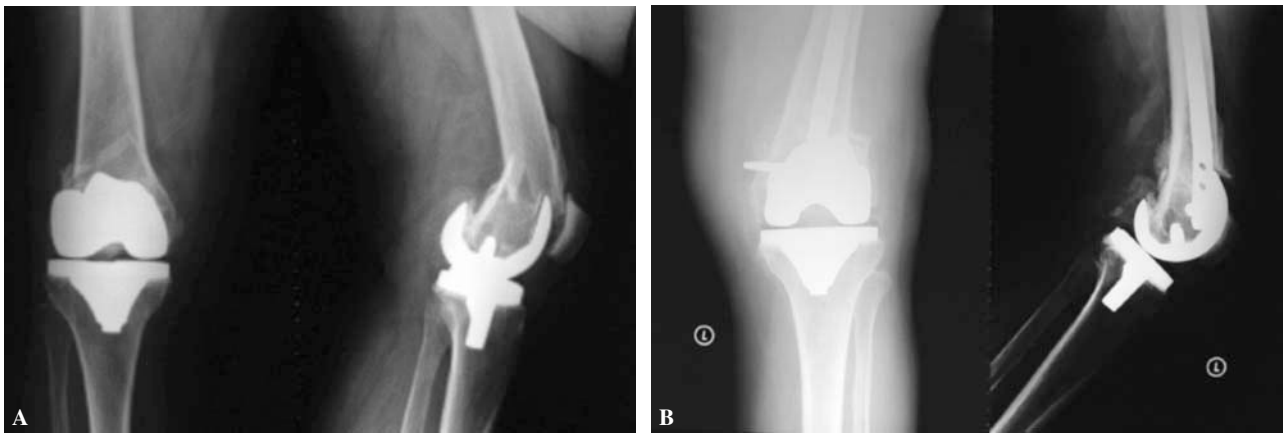

Figure 1. *(A) Displaced periprosthetic distal femoral fracture. Anterior osteotomy was excessive, which weakened the anterior cortex. (B) X-ray view at 3 months: the fracture has been fixated with a retrograde nail.*

DISCUSSION

Periprosthetic distal femoral fractures are rare and their treatment has not been exempt from controversy, especially as far as displaced comminuted fractures are concerned. Among the risk factors considered to be associated with the appearance of these fractures we could mention an excessive osteotomy that weakens the anterior femoral cortex, osteoporosis and circumstances leading to the onset of osteopenia, such as rheumatoid arthritis and continuous steroid

Figure 2. *(A and B) Periprosthetic fracture with a 10° valgus deformity as well as a slight recurvatum after retrograde femoral nailing.*

use[2]. The existence of an excessive osteotomy at the anterior cortex has been studied as a significant factor predisposing to supracondylar fractures[5,6]. Both this and the presence of significant osteoporosis are factors related with the appearance of supracondylar fractures[7].

In our sample we observed a high incidence of older women, which would seem to indicate that osteoporosis is one of the factors most closely related with the occurrence of these periprosthetic fractures. We nevertheless did not perform any specific densitometric studies to ratify this assumption.

According to a subjective qualitative assessment, five of the patients had been subjected to a significant anterior femoral osteotomy, which could not be objectively quantified. In our view, treating osteoporosis in the susceptible population, together with a more hallow anterior femoral cut, avoid some of these periprosthetic fractures.

The main goal of the treatment of supracondylar fractures, in the presence of a stable prosthesis, are restoring the mechanical axis of the knee and maintaining a painless range of movement. When we find a stable implant and a displaced fracture, surgical treatment comes across as the option of choice. In cases of component loosening we must revise them using appropriate revision implants[8].

For more stable undisplaced or minimally displaced fractures, conservative treatment is generally accepted to yield good results. In cooperative patients who tolerate lengthy immobilizations non surgical treatment of undisplaced fractures has obtained 80% of favorable results[9].

The evolution of the treatment of displaced distal femoral periprosthetic fractures indicates that surgical treatment has obtained better results with the development of new techniques. In 1994, Chen et al published a review of periprosthetic fractures indicating that satisfactory results for this type of fracture treated conservatively reached 67%, as compared with 61% for patients treated surgically[1]. Both groups showed a similar complications rate (up to 30%). These were infections, malunions and nonunions).

However, more recent studies have shown better results with different surgical techniques. Most of the published series include the use of open reduction and plating for stabilization. Currently, with the advent of minimally invasive techniques, several papers have been published that have used minimally invasive fixation (LISS) with favorable results[10,11]. The rationale of these systems is similar to that of MIS intramedullary nailing. Among the problems related to these plates are the technical difficulties inherent in their application, given that the surgeon should have large experience of this type of system, and the need to reduce the fracture prior to fixation.

The use of intramedullary nailing for the treatment of this type of fractures is a relatively recent development. In 1994, Mc Laren et al published a series of 7 periprosthetic fractures with better results than those obtained with open reduction and plate osteosynthesis[12]. Other authors have corroborated these results with comparable good results[3,12,13].

The advantages of intramedullary fixation are: to preserve the fracture hematoma, its use does not require an extensive soft tissue exposure, and to provide good stabilization of the fracture.

Our study includes a total of 12 patients treated with retrograde nailing for displaced femoral fractures. In our view, the results obtained are satisfactory, in line with those of prior publications[10,14,15]. In all of our patients healing occurred in less than 4 months, with no fixation defects that required a revision. Our patients did not have significant complications or any deep postoperative infection.

In conclusion, we believe that the use of retrograde intramedullary nailing in the treatment of periprosthetic distal femoral fractures can yield good results, with a low rate of complications.

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Conflict of interests

The authors have declared that they have no competing interests.