Helical Plate Osteosynthesis in Distal Femur Fractures

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ABSTRACT

Introduction: The use of double osteosynthesis for the treatment of fractures of the distal femur with metaphyseal comminution (AO 33C2, C3) and periprosthetic fractures (Vancouver C) provides greater stability. The use of helical plates has increased in order to avoid vascular damage related to the approach. **Materials and Methods:** Between 2017 and 2021, six patients were treated by double plate osteosynthesis (helical plate by medial approach). The series consisted of four females and two males, 66% (4 patients) had distal femoral fractures, and the rest (33%, 2 patients) were diagnosed with Vancouver C periprosthetic fractures. **Results**: In all cases, radiographic consolidation was observed 6 months after surgery, with a normal return to activities of daily living. None of them presented an associated neurovascular injury. **Conclusion:** The helical plate is a great option in distal femur fractures and Vancouver C periprosthetic femoral fractures. By applying the basic principles of osteosynthesis, sophisticated materials can be supplied, obtaining good clinical, functional, and radiographic outcomes.

Keywords: Helical plate; distal femur fractures; femur osteosynthesis; periprosthetic fractures.
Level of Evidence: IV

Osteosíntesis con placa helicoidal en las fracturas de fémur distal

RESUMEN

Introducción: En pacientes con fracturas de fémur distal con alto grado de conminución metafisaria (AO 33C2, C3) y fracturas periprotésicas (Vancouver tipo C), el uso de doble osteosíntesis brinda mayor estabilidad a la fractura. Las placas helicoidales se emplean cada vez más con el objetivo de evitar dañar elementos nobles relacionados con el abordaje. **Materiales y Métodos**: Entre 2017 y 2021, seis pacientes fueron tratados mediante osteosíntesis con doble placa (por vía lateral y helicoidal por vía medial). La serie se compone de cuatro mujeres y dos hombres. El 66% (4 pacientes) tenían fracturas de fémur distal, y el resto (33%), fracturas periprotésicas tipo Vancouver C. **Resultados**: Se observó la consolidación radiográfica en todos los pacientes, a los 6 meses de la cirugía, con retorno normal a la activad previa. Ninguno sufrió una lesión vasculonerviosa asociada. **Conclusiones:** La placa helicoidal es una gran opción para las fracturas de fémur distal con conminución y las fracturas femorales periprotésicas tipo Vancouver C. Esto demuestra que, aplicando los principios básicos de osteosíntesis, con una técnica sencilla, se pueden suplir materiales más sofisticados, y obtener resultados radiográficos similares.

Palabras clave: Fracturas de fémur distal; placa helicoidal; osteosíntesis de fémur distal; fracturas periprotésicas.
Nivel de Evidencia: IV

INTRODUCTION

Distal femur fractures make up 6% of all femur fractures. The classic treatment consists of osteosynthesis with a plate via the lateral approach, which allows a stable configuration with a good rate of consolidation and achieves good outcomes.[1]

In some types of fractures, osteosynthesis via the lateral approach does not provide sufficient stability (complex articular fractures, with a high degree of metaphyseal comminution). In these cases, double osteosynthesis (laterally and medially) is preferred to provide greater stability to the fracture and prevent varus collapse.

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Loosening, bone necrosis, and nonunion have been reported in normal osteosyntheses in these distal femur fractures, so it may be necessary to develop new alternatives to treat them.[2]

The problem lies in the complications of performing osteosynthesis through a medial approach, with the use of smaller plates that, in certain cases, seem insufficient, taking into account the noble structures present.

In 2002, Fernández Dell'Oca described the biomechanical principles of helical implants. Regarding distal femur fractures, he proposed a helix-shaped implant, placed medially and ending on the anterior face of the proximal femur. In this way, the noble structures of the area are avoided and longer implants can be placed to provide greater stability (with a good rate of consolidation, without material fatigue and a low rate of nonunion).[3]

There is scant literature available on the subject of distal femur fractures, although the use of helical plates for humerus fractures has been widely analyzed.[3]

The objectives of this article are to describe a series of cases in which helical plate osteosynthesis was performed in patients with distal femur fractures, to explain its placement technique, and to communicate the results obtained.

MATERIALS AND METHODS

We carried out a descriptive study in a national referral center, on patients with distal femur fracture and periprosthetic fractures treated by double plate osteosynthesis (osteosynthesis by lateral approach and helical plate by medial approach), during the period between January 2017 and January 2020.

The inclusion criteria were: patients with open or closed type C2 and C3 fractures of the distal femur (according to the AO classification), or Vancouver type C periprosthetic fractures of the hip treated by double-plate osteosynthesis with a medial helical plate. Exclusion criteria were: pathological fractures, clinical or biochemical signs of infection, and follow-up <6 months.

We recorded the following variables obtained retrospectively from the archive of medical records and images: age, sex, fracture classification, pain in the last available control after consolidation according to the visual analog scale, stability and functionality of the knee. Stability was retrospectively evaluated by observing the rate of osteosynthesis failure, evaluating cases of nonunion (lack of radiographic consolidation, pain, focus mobility >3 months) and material fatigue (breakage of the osteosynthesis material). In all patients, the KOOS score (Knee injury and Osteoarthritis Outcome Score) was used, which allows estimating functional postoperative outcomes of the knee and quality of life.[4,5]

Surgical technique

Osteosynthesis was performed using a conventional lateral approach for the distal femur. To achieve the length and reduction of the fracture, a temporary external fixator was used (Figure 1). For osteosynthesis via the lateral approach, low-profile, locking anatomical distal femur plates were used.

The helical plates were crimped with straight plates with 12 to 15 3.5 mm holes (Figure 2).

From a small medial exposure, the helical plate was inserted through the submuscular space reaching the existing proximal exposure for the lateral implant. Both plates "bridge" the metaphyseal comminution zone.

Figure 1. Intraoperative images. The placement of the temporary external tutor to maintain the length is observed.

Statistical analysis

Categorical variables were described in number and percentage; and numerical variables, as median and range. For the analysis of the variables, the SPSS Statistics 25 program was used.

The confidentiality of the data was respected, adhering to the Declaration of Helsinki. The collection of information and the review of medical records were carried out with the prior consent of the patients.

Figure 2. Intraoperative image. Helical plate crimped to measure.

RESULTS

During the study period, six patients with a distal femur fracture were included. The series consisted of four (67%) women and two men (33%). Four (67%) had a distal femur fracture (one of them was a young patient with paraplegia from an early age) and two (33%) had a Vancouver type C periprosthetic fracture (Table 1).

Table 1. Sample Description

Variable	Outcomes
Cases	6
Age, median (range)	72 (38-81)
Sex, n (%) Female Male	 4 (66.6) 2 (33.3)
Diagnosis, n (%) Femur fracture Periprosthetic fracture	 4 (66.6%) 2 (33.3%)
Radiographic consolidation, n (%)	6 (100%)
Visual analog scale, median (range)	3 (2-4)
Osteosynthesis fatigue, n (%)	0
Nonunion, n (%)	0
Follow-up (months), median (range)	24 (6-36)

In all patients, radiographic consolidation was observed six months after definitive surgery. Two patients in the sample had, at the time of osteosynthesis, metaphyseal defects that were resolved with cement spacers and antibiotics, thus requiring a new intervention with the placement of a bank graft. In these cases, weight-bearing was delayed for six weeks, at which time the second surgical stage was performed, which consisted of spacer removal and filling of the defect with cadaveric bone graft. Again, weight-bearing was delayed for six weeks, and union was achieved in both cases. The rest of the patients started a progressive weight-bearing protocol that consisted of partial weight-bearing for three weeks and then full weight-bearing. None had an associated neurovascular injury (Figures 3-6).

Figure 3. Anteroposterior radiographs of the femur. A Vancouver type C periprosthetic hip fracture and the result after double medial and lateral osteosynthesis are observed.

Figure 4. Anteroposterior and lateral panoramic radiograph of the femur in the preoperative period. A fracture of the distal femur with metaphyseal comminution is visualized.

Figure 5. A. Anteroposterior radiograph of the femur. **B.** Anteroposterior radiograph of the knee. **C.** Lateral radiograph of the femur. Immediate postoperative period. Medially placed helical plate with 10 holes adapted to the distal femur and management of the metaphyseal defect with a cement spacer.

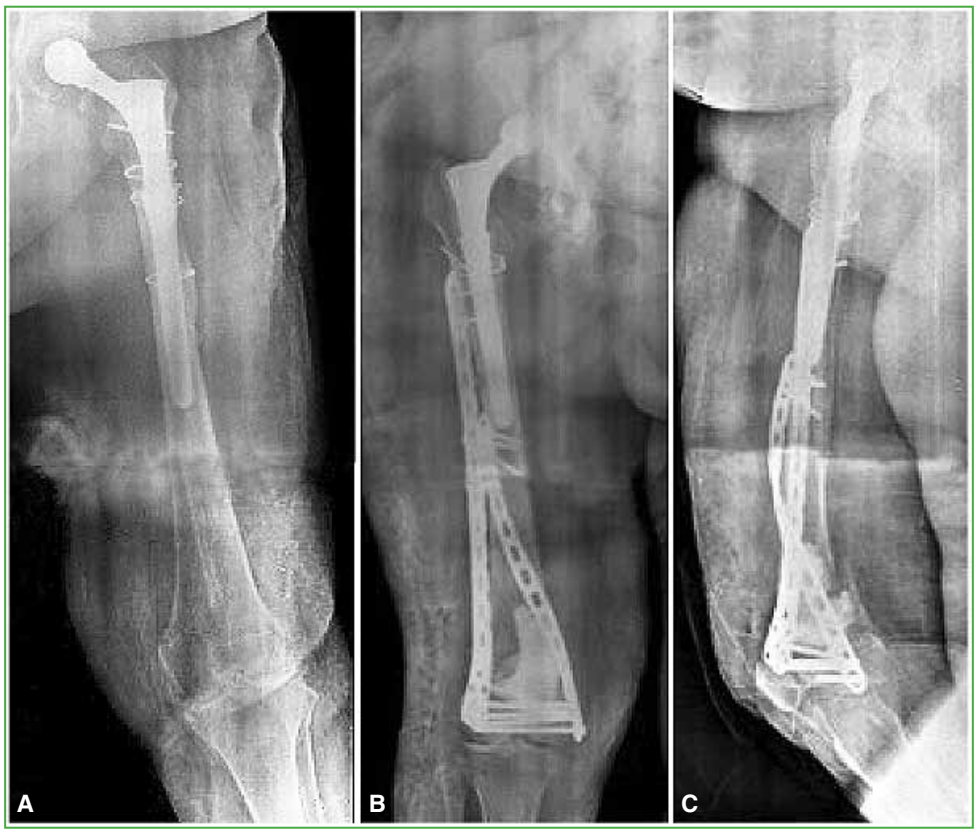

Figure 6. A. Anteroposterior panoramic radiograph of the femur in the preoperative period. A Vancouver type C periprosthetic hip fracture with compromise of the distal femur is observed. **B and C.** Anteroposterior and lateral radiographs of the femur in the postoperative period. Osteosynthesis with helical plate

The average postoperative pain score after fracture union was 3. The patient with quadriplegia was not evaluated in this regard (Table 2). The radiographic follow-up was performed in the immediate postoperative period, at 3 and 6 weeks, and at 3, 6, 12, 18, and 24 months. Table 3 describes the functional outcomes according to the KOOS score.[6,7] The median follow-up was 24 months (range 6-36).

Table 2. Description of the cases

Cases	Sex	Classification*	Pain (VAS)	Consolidation	Implant fatigue	Infected nonunion
1	F	AO 33 C2	-	Yes	No	No
2	F	AO 33 C3	2	Yes	No	No
3	F	Vancouver C	3	Yes	No	No
4	F	Vancouver C	3	Yes	No	No
5	M	AO 33C2	4	Yes	No	No
6	M	AO33C3	3	Yes	No	No

F = female, M = male, VAS = visual analog scale.
*Distal femur fractures were classified according to the AO classification system and the Vancouver classification for cases of periprosthetic fractures.

Table 3. KOOS (Knee injury and Osteoarthritis Outcome Score).

Patient	Pain	Activities of daily living	Function, sports, and recreational activities	Quality of life	Symptoms
1	-	96.88	65	87.5	82.14
2	91.67	94.12	55	88.5	71.3
3	92.53	91.78	75	81.25	78.57
4	87.67	94.36	65	75	89.29
5	93.48	90.15	65	93.75	92.86
6	85.32	88.24	55	75	77.47

DISCUSSION

The helical plate is a conventional, crimped straight plate. Its application provides rigidity to the system, as it improves resistance to axial load, and it has already been used successfully in various types of long bone fractures.[3] It acts as an internal fixator, it is an easy technique to apply and requires minimal additional exposure. It replaces the missing bone support by acting as a tension band; therefore, it supports and protects with an improved lever arm.[4] In our series, we used 3.5mm straight plates, with between 12 and 15 holes. We chose locking plates to obtain more rigidity in the fixation.

In their joint work, Fernández and Perren concluded that it provides an efficient discharge and its application causes minimal tissue trauma at the fracture site, thus avoiding the biological disadvantage of conventional double plating, that is, additional surgical exposure of the fracture site.[4,5] In our series, minimally invasive approaches allowed early recovery and provided satisfactory functional outcomes in short-term follow-up (Table 3).

In a biomechanical study, Sezek et al. compared straight plates with helical plates placed medially. They maintained that conventional straight osteosynthesis induces undue stress protection of the fractured bone and may cause weakening and loosening of the segment. Another disadvantage is the lack of torsional capacity, which makes plate placement difficult and can lead to a degree of malrotation of the fracture. These authors concluded that helical plates have greater stability against axial load and torsional forces compared to conventional straight plates; however, the straight plates had more resistance to flexion forces.[8] The latter is probably due to the fact that since helical plates are crimped, they are weaker at the points where the force was applied.[9] In our series, two patients presented severe metaphyseal defects of the distal femur, for which the use of double osteosynthesis increased the rigidity of the system, and allowed the patients to walk with immediate partial weight-bearing after definitive surgery and full weight-bearing at six weeks.

As in the initial study by Fernández Dell'Oca, Krishna stated that helical plates allow a better adaptation of the screws, mainly in oblique fractures, which improves their stability and resistance to rotational deformity.[10]

The limitations of this study are the small number of patients treated with this method, the follow-up and the analysis of short-term results. Several questions regarding the indications remain, such as the appropriate length of the plate, the number of screws required, the type of fracture appropriate for this technique, and the appropriate crimping angle.

CONCLUSIONS

We described six cases of osteosynthesis in the distal femur with a helical plate using a medial approach. Good clinical and radiographic outcomes were obtained in the short term, which coincides with the published series. The helical plate is a great option in patients with comminuted distal femur fractures or Vancouver type C periprosthetic femoral fractures. The application is simple, the effect is efficient, and the biology remains intact. This shows that, by applying the basic principles of osteosynthesis and with a simple technique, more sophisticated materials can be supplied, and similar radiographic outcomes can be obtained.

Conflict of interest: The authors declare no conflicts of interest.

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