Basicervical Fractures Treated with Single-Screw Cephalomedullary Nail. Case Series and Review of the Literature

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ABSTRACT

Background: Given the rotational instability of basicervical fractures, recent studies suggest using a spiral blade, a second screw or compression screws instead of single-screw cephalomedullary nail fixation. **Objective:** The aim of our study is to analyze the outcomes of basicervical fractures treated with single-screw cephalomedullary nails. **Materials and Methods:** This is a retrospective study based on a case series identified from all extracapsular femoral fractures treated with single-screw cephalomedullary nails in our hospital from 2016 to 2020. Clinical records and radiographs from 269 patients were reviewed; only 12 (6.4%) subjects met inclusion criteria (two-part non-pathologic fractures with at least a 9-month follow-up). Different factors were evaluated, including: tip-apex distance, cephalic screw position, reduction quality, surgical time, complications and re-operations; differences between patients who experienced complications and those who did not were also assessed. **Results:** Four subjects out of the 12 included patients experienced fixation failure and implant cut-out. There were no statistically significant differences between subjects with and without cut-out regarding the analyzed variables. **Conclusions:** The high cut-out rate observed in our sample suggests considering the hypothesis that single-screw cephalomedullary nail fixation should not be used in basicervical fractures. Alternative fixation devices capable of controlling the high rotational instability of these fractures may be preferable.

Keywords: Basicervical fracture; cut-out; single-screw; cephalomedullary nail.

Level of Evidence: IV

Fracturas basicervicales tratadas con clavo intramedular con tornillo cefálico único. Serie de casos y revisión bibliográfica

RESUMEN

Introducción: Debido a la inestabilidad rotatoria de las fracturas basicervicales, en estudios recientes, se sugiere el uso de una hoja espiral, doble tornillo o tornillos de compresión en lugar del tornillo cefálico único. **Objetivo:** Analizar los resultados de las fracturas basicervicales tratadas con tornillo cefálico único en nuestro centro. **Materiales y Métodos:** Estudio retrospectivo de una serie de casos formada a partir de la revisión de todas las fracturas extracapsulares de fémur proximal tratadas con clavo intramedular con tornillo cefálico único entre 2016 y 2020. Se revisaron las historias clínicas y las radiografías de 269 pacientes, y solo 12 (6,4%) de ellos cumplieron los criterios de inclusión (fracturas en dos fragmentos no patológicas y con seguimiento mínimo de 9 meses). Se evaluaron diferentes factores, como distancia punta-ápex, posición del tornillo cefálico, calidad de la reducción, tiempo quirúrgico, complicaciones y reintervención, y se analizaron las posibles diferencias entre los pacientes que sufrieron complicaciones y los que no. **Resultados:** Cuatro de los 12 pacientes tuvieron una falla de la fijación que evolucionó a *cut-out* (única complicación identificada en la muestra). No hubo diferencias estadísticamente significativas entre pacientes con *cut-out* o sin *cut-out* respecto al resto de variables analizadas. **Conclusiones:** La elevada proporción de pacientes que desarrollaron *cut-out* sugiere considerar la hipótesis de que debería evitarse fijar las fracturas basicervicales con tornillo cefálico único. Dada su alta tasa de inestabilidad rotatoria, podría ser más apropiado el uso de implantes que la contrarresten.

Palabras clave: Fracturas basicervicales; *cut-out*; tornillo cefálico único; clavo intramedular.

Nivel de Evidencia: IV

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INTRODUCTION

The frequency of hip fractures has been increasing in recent years due to the increasing age of the population.[1] These fractures have a high morbidity and mortality rate, cause great limitations and difficulties in regaining walking, and can lead to serious complications, such as venous thromboembolic disease**,** pneumonia, or pressure ulcers.[2] This is why early surgical intervention and early initiation of walking are essential in most of these patients.

A subtype of hip fractures are basicervical fractures, which are considered to be transitional fractures between the intracapsular and extracapsular zones. They are typically characterized as two-fragment fractures with a line at the base of the femoral neck, medial to the intertrochanteric line, above the lesser trochanter (Figure 1).[1,2] They are infrequent, with a prevalence ranging from 1.8% to 7.7%.[3,4] Their treatment is complex, because their intermediate situation between intracapsular and extracapsular fractures causes high axial biomechanical instability (their line, more vertical and lateral than that of pertrochanteric fractures, is subjected to greater shearing and varus forces) and rotational instability, since the proximal fragment lacks muscular insertions to fix it, which leads to a high rate of complications (up to 54%), among which the cut-out phenomenon stands out.[4-6] For this reason, several authors consider that its management should differ from that of other extracapsular fractures.[4-7]

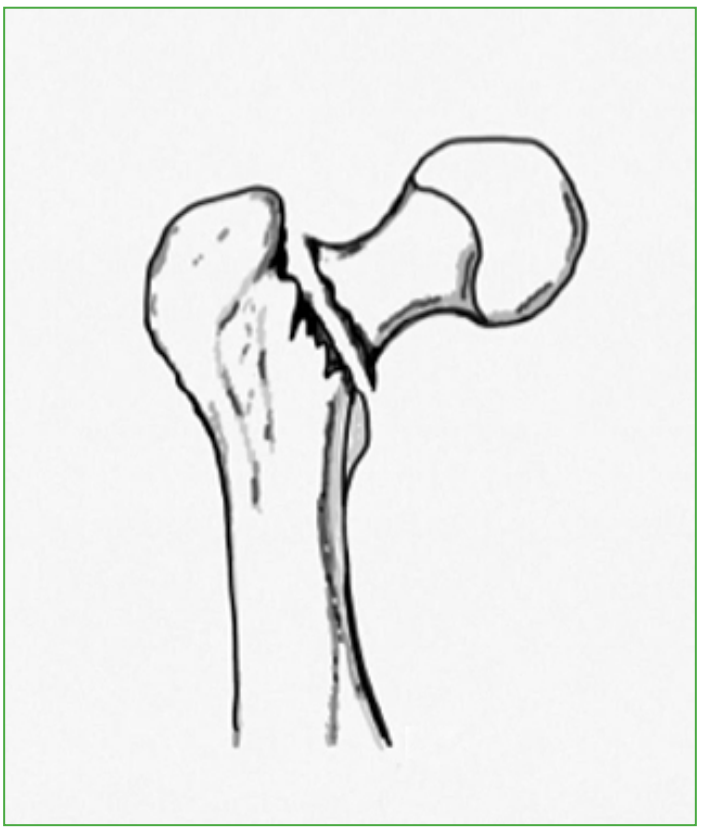

Figure 1. Schematic representation of the basicervical fracture.

Although the most frequent treatment, as in peritrochanteric fractures, is intramedullary nailing with a single cephalic screw,[8] recent studies suggest that, due to their rotational instability, basicervical fractures should be considered a specific risk factor for secondary displacement or failure of intramedullary nail fixation.[4,5,9] As a result, femoral head fixation other than a single cephalic screw is required, and spiral blade, double screw, or compression screws are recommended.[4,7]

The purpose of this study was to analyze the results obtained with intramedullary nailing treatment with a single cephalic screw in basicervical fractures in our site. In addition, a non-systematic literature review was performed to try to achieve a better understanding of the reasons that may lead to failure of surgery in this type of fracture.

MATERIALS AND METHODS

A descriptive, observational, retrospective, cross-sectional study was conducted on a case series formed from the review of all patients with extracapsular fractures of the proximal femur operated on at our site between 2016 and 2020.

Based on clinical history and radiographs (anteroposterior and lateral), patients with a basicervical fracture were included, defined radiographically as a two-fragment fracture with a line at the base of the femoral neck, medial to the intertrochanteric line, above the lesser trochanter, but more lateral than the transcervical fracture (AO type 31B2.1). To achieve a more homogeneous sample, those with 'equivalent basicervical' fractures (AO 31A1.1, A2.1, A2.1, A2.2, A2.3) were excluded, as were those with disease secondary to tumors; follow-up <9 months or who had not undergone surgery with a Gamma-3 model single cephalic screw intramedullary nail (Stryker®, Kiel, Germany). Two of the authors independently reviewed the patients to identify those who met the inclusion criteria; in case of disagreement, a third reviewer not involved in the study design was consulted.

Sociodemographic (age and sex), clinical (fracture laterality and time of admission), surgery-related (time to surgery, duration of surgery, cephalic screw angle, and requirement for open reduction), and postoperative (early weight bearing in the first 48 hours following surgery) attributes were all analyzed.

In the postoperative control radiograph, the tip-apex distance (TAD) was determined according to the formula of Baumgaertner et al.[10] The position of the cephalic screw was classified as good, acceptable, or poor, according to Gardenbroek.[11] The quality of the reduction was evaluated according to the criteria proposed by Fogagnolo.[12] These variables were evaluated jointly by two of the authors.

Surgical complications included fixation failure, defined as fracture collapse and migration of the cephalic screw in the femoral head (cut-out), absence of clinical-radiological consolidation after six months, and the need for reintervention.

This study was approved by the Clinical Research Ethics Committee of our institution.

Statistical Analysis

Quantitative variables are described as median (interquartile range, IQR), while qualitative variables are expressed as absolute numbers. The data were analyzed with the Mann-Whitney U test for quantitative variables and the chi-squared test or Fisher's exact test for qualitative variables. A bilateral significance level of 0.05 was established. All calculations were performed with the SPSS program version 25.

RESULTS

Of the 269 extracapsular femoral fractures treated in our site, 12 patients (6.4%) had a basicervical fracture and met the inclusion criteria, with no discrepancies between the two evaluating authors. All were adults and the fracture had been produced by low-energy mechanisms.

The median age was 78 years (IQR 66.8-89.0), 75% were women. In eight cases, the fracture was on the left side. The most commonly used nail angle was 125° (8 patients), the median TAD was 15.6 mm (IQR 11.3-22.4) and 11 reductions were considered anatomic, open reduction was not necessary in any of the cases (Table 1). All patients started with early weight bearing during admission.

When data were collected, 11 of the 12 patients were alive. One had died of *Staphylococcus aureus* bacteremia secondary to a skin infection unrelated to the osteosynthesis process.

In eight cases, fracture healing was achieved without implant mobilization or collapse. In the other four cases, there was a fixation failure that evolved to cut-out, three of them were operated again (Figure 2); the fourth patient was offered a new surgery, but refused it. The median TAD in these four cases was 23.9 mm, compared to 13.8 mm in patients without this complication (p = 0.09); however, as can be seen in Table 1, the only two patients in

the entire sample with a TAD >25 mm presented cut-out. In three of the cases with cut-out, the position of the cephalic screw according to the Gardenbroek classification was "acceptable" and only one had a "poor" position; in three of them, the reduction was "good" according to Fogagnolo (Table 1).

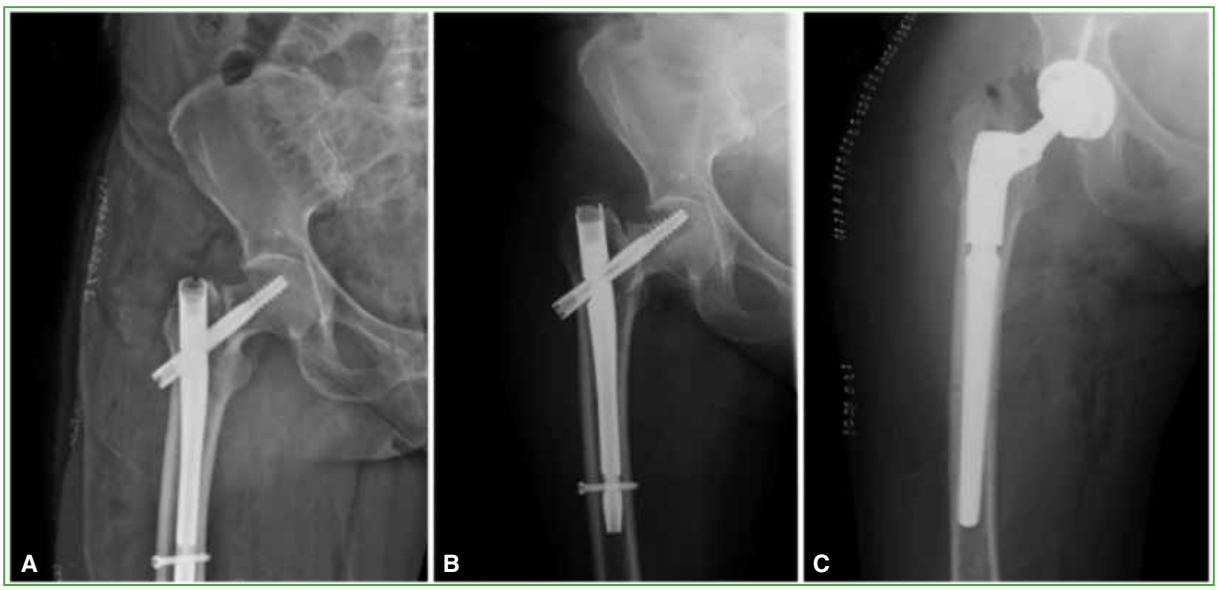

Figure 2. Anteroposterior hip radiographs of case number 10. **A.** Immediate postoperative period: a varus reduction is observed; the cephalic screw is in a superior position and has an increased tip-apex distance. **B.** Two months after surgery: cut-out implant failure is observed. **C.** After reintervention with total hip prosthesis.

Table 1. Clinical, radiographic, and surgical characteristics and complications of patients with basicervical fractures.

Patient	Sex	Age (years)	Laterality	TAD (mm)	Cephalic screw angle	Cephalic screw position (Gardenbroek)	Type of reduction (Fogagnolo)	Surgery time (min)	Complications	Reintervention
1	F	46	Right	8.8	125º	Acceptable	Good	93	No	-
2	F	95	Left	11.4	125º	Good	Good	55	No	-
3	F	88	Left	11.1	125º	Acceptable	Acceptable	80	No	-
4	F	89	Left	15.4	130º	Acceptable	Good	40	No	-
5	F	73	Right	15.8	125º	Acceptable	Good	45	No	-
6	M	43	Left	35.7	130º	Acceptable	Good	125	Cut-out	Yes
7	F	83	Left	16.5	130º	Good	Good	58	No	-
8	M	72	Left	21.8	125º	Good	Good	25	No	-
9	F	73	Left	11.3	125º	Acceptable	Good	35	Cut-out	No
10	F	65	Right	22.7	125º	Poor	Acceptable	65	Cut-out	Yes
11	M	89	Left	25.2	125º	Acceptable	Good	68	Cut-out	Yes
12	F	91	Right	12.3	130º	Acceptable	Good	115	No	-

F = female; M = male; TAD = tip-apex distance.

The median surgery time was 66.5 min in patients with cut-out and 56.2 min in the rest (p = 0.61). Patients without cut-out tended to remain hospitalized longer (Table 2), because, in this group, three requested an intermediate care facility for discharge, so they could not be discharged until it was granted.

Table 2. Description and analysis of different variables in cut-out and non-cut-out patients.

	Group with cut-out	Group without cut-out	p
Age (years)	69.0 (48.5-85.0)	85.5 (72.3-90.5)	0.23
TAD (mm)	23.9 (14.2-33.1)	13.8 (11.2-16.3)	0.09
Time until surgery (days)	2.0 (0.3-3.8)	2.5 (1.3-4.8)	034
Surgery time (min)	66.5 (42.5-110.8)	56.2 (41.3-89.8)	0.61
Hospital stay (days)	6.0 (4.3-10.0)	12,5 (8.5-15.5)	0.05
Cephalic screw position (Gardenbroek)			
Good	0	3	
Acceptable	3	5	
Poor	1	0	
Reduction type (Fogagnolo)			
Good	3	7	
Acceptable	1	1	

Data are expressed as median (interquartile range) for quantitative variables and as absolute number for qualitative variables. TAD = tip-apex distance.

The cut-out was observed in all individuals within three months of the intervention; no trauma or triggering falls were identified in any of them. There were no other intraoperative complications in the 12 cases. Fracture healing had not occurred in any case of cut-out before the complication was detected. At the third month follow-up, sufficient consolidation was visible in the control radiographs of the other patients. Only one case (number 3) showed femoral neck varization on a control radiograph one month after surgery.

DISCUSSION

Hip fractures with a basicervical line are rare; their definition is complex and not always unanimous, which explains why their prevalence is highly variable in studies (1.8%-7.6% of hip fractures).[4,5,7,13,14] In fact, it is considered that up to two thirds of basicervical fractures are misclassified by an incorrect axial hip radiograph.[7,13]

To avoid confusion and homogenize the sample in our study, we only included fractures in two single-line fragments at the base of the femoral neck, medial to the intertrochanteric line, and above the lesser trochanter, as defined by Blair et al.[3] No other fracture lines or equivalent fractures have been included;[14] thus, we have obtained a prevalence of 6.4%, very similar to that of similar studies.[4,5,7]

Given their low frequency and their intermediate intra/extracapsular location, treatment is controversial, as they have characteristics of both types of fractures. They have rotational instability due to the lack of muscle insertions that stabilize the proximal fragment (as seen in subcapital fractures) and axial instability due to the highly vertical line (as seen in extracapsular fractures).[2,6,7] This combination of instabilities determines high complication rates (9-54%);[4,5,7] in our study, it was 33%.

Over time, basicervical fractures have been treated in different ways: as intracapsular fractures or as extracapsular fractures. These fractures have less lateral bone support and are more susceptible to varus forces because they are more vertical and lateral than a typical subcapital line. According to various studies,[3,6,7,15] cannulated screws (the standard therapy for subcapital fractures) produce more complications (19-50%) than other devices, such as the DHS-type sliding screw-plate (8-10%).[7,13] Therefore, it is possible that treating unstable fractures like basicervical fractures as extracapsular, using intramedullary nailing, yields better outcomes than employing a sliding screw plate.[2]

In our series, the complication rate (cut-out) was 33%, in agreement with studies whose surgical management was similar.[4,5] Furthermore, it should be taken into account that, unlike other authors (Hu et al.[8]), we have selected only those simple basicervical line; if more complex fractures with associated basicervical lines had been included, it is likely that even higher complication rates would have been obtained.[7,14]

Although there are studies reporting favorable outcomes in terms of postsurgical complications with the implants already discussed (DHS or intramedullary nails),[3,15,16] other therapeutic options have been proposed for basicervical fractures, including cephalic spiral blades. These differ from screws in their biomechanical and clinical behavior because, unlike screws, which require reaming of the bone for placement, the spiral blade is introduced by compacting the cancellous bone. This improves the stability of the microtrabecular system around the implant, which is very significant because microtrabecular fracture is thought to be one of the triggering elements in the process that causes cut-out. According to studies such as that of Lenich et al.,[17] cut-out starts with microtrabecular fracture, followed by rotation of the femoral head around the implant, migration of the implant and varus collapse of the fracture. Thus, fracture fixation with a spiral blade has been reported as better than the single cephalic screw in several studies.[5,7,8,18-22] However, cut-out can also occur with the spiral blade; moreover, it has a paradoxical behavior: although its resistance to cut-out initiating forces is superior than that of the cephalic screw, once implant migration has begun, the development of this complication is more rapid.[7] Likewise, this type of blade has been associated with other complications such as cut-through, which consists of perforation of the femoral head by the spiral, which is introduced into the hip joint, without fracture displacement.[23]

Another widely used technique is to add an anti-rotation screw outside the implant to block rotational instability.[6,14,18] However, the additional screw has been used more with DHS sliding screw-plate systems, but the clinical and biomechanical results have been mixed.[6,14,18,24] Other ways to compensate for rotational instability may include cementing the cephalic implant or using implants with two integrated screws in association.[7,25]

It is important to note that the correct choice of implant does not exempt from the proper surgical technique. Thus, the location of the cephalic implant must have a correct TAD (<25 mm) and a center-to-center location in both radiographic projections.[4,7,11] In our results, there was a difference in the median TAD, which was higher in patients with cut-out; although this difference was not statistically significant, there was a tendency to significance ($p = 0.08$). Additionally, the only two cases in which the TAD was >25 mm had cut-out. The position of the cephalic screw was satisfactory or acceptable in the majority of the patients; there was just one case (number 10) where the screw was situated in a central-superior position and developed cut-out. Therefore, it is possible that these errors in surgical technique may have influenced the development of this complication.

It is also important to remember that surgical planning is fundamental in these cases, both the correct identification of the basicervical fracture and the correct selection of the cephalic screw angle.

The limitations of this study are its retrospective design, the lack of a control group, and the small sample size due to the low frequency of strict basicervical fractures (the only ones included in this study in order to ensure as homogeneous a sample as possible).

In view of our results and the literature review, we consider that basicervical fractures should be treated with special care, with proper implant selection and correct surgical technique. In this regard, the choice of devices that counteract the rotational instability inherent to this type of fracture, either by means of spiral blades, anti-rotational screws outside the nail, nails with two integrated screws or implants augmented with cement, could be useful.

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

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