Instability Risk Factors in Total Hip Arthroplasty for Femoral Neck Fracture

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ABSTRACT

Introduction: One of the most relevant complications of total hip arthroplasty (THA) in the treatment of fractures is a dislocation rate of 10%, which is 5 times higher than that of THA for osteoarthritis. Our objective was to determine the dislocation rate in patients treated with THA due to femoral neck fracture and to evaluate the cause of dislocation. **Materials and Methods:** We carried out a retrospective study on 110 THAs in patients with femoral neck fractures (the average age was 69 years, and 71% were women). The type of fixation of the prosthesis, the size of the head, the offset, and the surgical approach were evaluated. The angle of acetabular inclination and anteversion and the comorbidities were measured. **Results:** 72% of surgeries were performed through the posterolateral approach. The anterolateral approach is associated with a 7° more vertical cup (p=0.001). 65.4% of the heads were 32 mm. 15% of the small heads (22 and 28mm) (3/20) and only 1% of the large heads (1/90) dislocated (p=0.0027). No 36-mm heads were dislocated. Depression, Parkinson's, and Alzheimer's disease were the most frequent neurological comorbidities. **Conclusions:** Small-diameter heads, in combination with poor positioning of the prosthesis and neurocognitive diseases, are associated with greater instability. Using prosthetic heads with a diameter of 36 mm and a correct orientation of the components is sufficient to ensure stability.

Keywords: Total hip replacement; instability; risk factors; hip fracture.

Level of Evidence: III

Factores de riesgo de inestabilidad en el reemplazo total de cadera por fractura medial de cadera

RESUMEN

Introducción: Una de las complicaciones más importantes de la artroplastia total de cadera en el tratamiento de las fracturas es la luxación, con una tasa del 10%, cinco veces mayor que la de la artroplastia total de cadera para osteoartrosis. El objetivo de este estudio fue conocer nuestra incidencia de luxación en pacientes sometidos a artroplastia total de cadera por fractura del cuello femoral y evaluar la causa de la luxación. **Materiales y Métodos:** Estudio retrospectivo en 110 pacientes sometidos a artroplastia total de cadera por fractura medial de cadera (edad promedio 69 años; 71% mujeres). Se evaluaron el tipo de fijación de la prótesis, el tamaño de la cabeza, el *offset* y el abordaje quirúrgico. Se midieron los ángulos de inclinación y de anteversión acetabulares y se registraron las comorbilidades. **Resultados:** El 72% de las cirugías fueron por vía posterolateral. La vía anterolateral se asoció con una copa 7° más vertical (p = 0,001). El 65,4% de las cabezas eran de 32 mm. El 15% (3/20) de las cabezas chicas (22 y 28 mm) y el 1% (1/90) de las grandes se luxaron (p = 0,0027). No se luxó ninguna cabeza de 36 mm. Las comorbilidades neurológicas más frecuentes fueron depresión, Parkinson y Alzheimer. **Conclusiones:** Las cabezas de pequeño diámetro junto con el mal posicionamiento de la prótesis y las enfermedades neurocognitivas se asocian a una inestabilidad mayor. El uso de cabezas de 36 mm y la correcta orientación de los componentes son suficientes para asegurar la estabilidad.

Palabras clave: Reemplazo total de cadera; inestabilidad; factores de riesgo; fractura de cadera.

Nivel de Evidencia: III

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INTRODUCTION

Approximately half of hip fractures correspond to a displaced femoral neck fracture (Garden types III or IV) of the subcapital region. These are associated with impaired mobility, loss of function, personal dependence, and are important causes of morbidity and mortality in the elderly.[1,2]

Surgical treatment options include internal fixation (not recommended in the elderly), hemiarthroplasty, and total hip arthroplasty (THA).

THA has been shown to lead to lower reoperation rates, less pain, better functional outcomes, and better ranges of motion than hemiarthroplasty. However, one of the most relevant complications of THA in the treatment of fractures is a dislocation rate of 10%, five times higher than that of THA for osteoarthritis, due to the combination of muscular insufficiency, cognitive and neurological disorders, and recurrent falls that characterize this patient population.[3,4] Obesity, excessive alcohol consumption, a posterolateral approach, neurodegenerative diseases, malposition of components and lumbar arthrodesis are risk factors for THA dislocation.

In recent years, large diameter heads, highly cross-linked polyethylene, and dual mobility designs have been shown to reduce osteolysis and the risk of dislocation.[5]

Currently, there is a tendency to indicate a dual mobility THA in primary surgery for displaced femoral neck fractures; however, we believe that the correct placement of the components of a conventional THA with a 36mm head and the restoration of abductor tension provide complete range of motion and sufficient stability in patients without comorbidities.

The objective of this study was to determine the dislocation rate in patients treated with THA for femoral neck fracture and to assess the cause of the dislocation.

MATERIALS AND METHODS

We carried out a retrospective study between January 2012 and May 2020. A total of 268 femoral neck fractures and 110 THAs were identified in 108 patients (Figure 1).

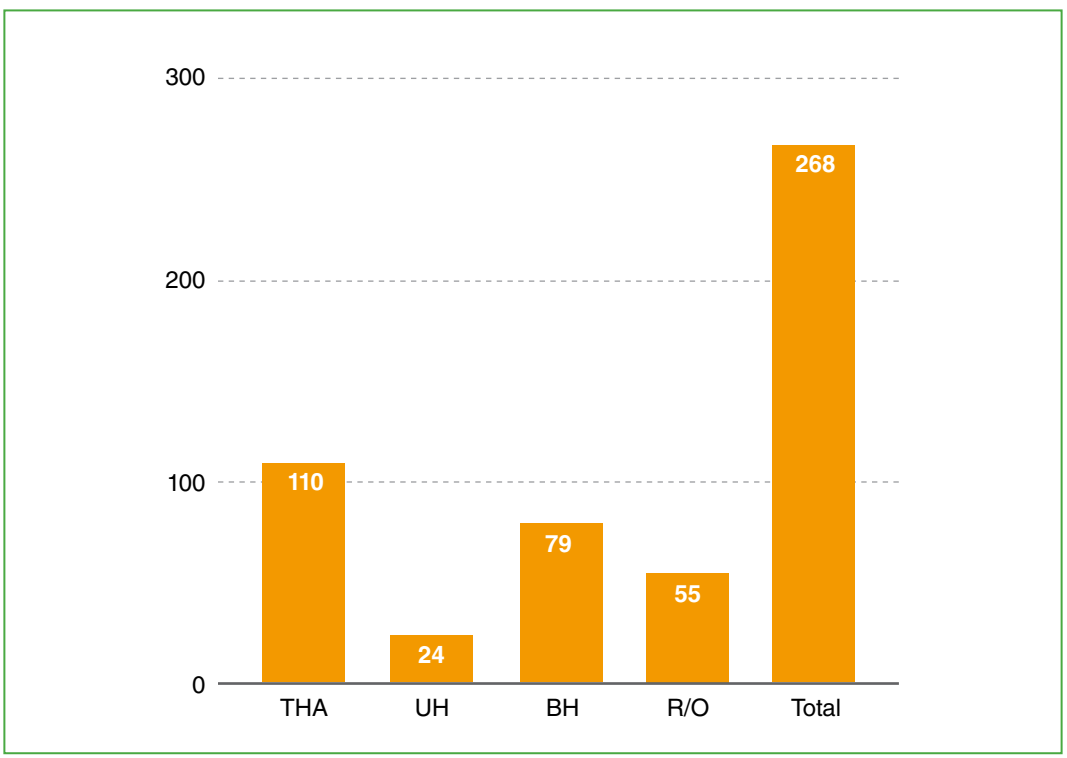

Figura 1. Total number of femoral neck fractures and treatments performed. THA = total hip arthroplasty, UH = unipolar hemiarthroplasty, BH = bipolar hemiarthroplasty. R/O = reduction and osteosynthesis.

The average age of the patients at the moment of surgery was 69 years, 78 were women (71%) and 32 men (29%). 50% were over 70 years old. The affected side was the right side in 51% and two patients had a bilateral fracture, both with a one-year difference between the fractures. According to Garden's classification,[6] 50% of fractures were type IV and 40% were type III. (Table 1).

Table 1. Demographics of the serie

Sex	
Female	78 (71%)
Male	32 (29%)
Age (mean)	69.31 (range 37-95)
Side	
Right	56 (51%)
Left	54 (49%)
Fracture type	
Garden I	5 (4.55%)
Garden II	6 (5.45%)
Garden III	44 (40%)
Garden IV	55 (50%)

We recorded the data on the type of prosthesis, including head size, offset, type of fixation, and surgical approach. Acetabular inclination and anteversion angles were measured according to the Pradhan[7] method with the Carestream® system. Likewise, we recorded the follow-up time as well as important comorbidities and complications derived from surgery, with special interest in dislocation.

Statistical Analysis

We performed an exploratory analysis (summary of measurements, frequency distribution tables and graphs – box plots, bar plots and histograms) of the patient sample, characterizing by sex, age, and the variables investigated.

RESULTS

The average follow-up was 35 months, with a minimum of 12 months in 54 patients and a maximum of 96 months in another four.

Each surgeon chose the surgical approach based on their individual experience. 72% of the surgeries were performed through the posterolateral approach and 28% through the anterolateral approach. There were no statistically significant differences when comparing the approach with respect to age, sex, operated side and Garden classification (p = 0.206, 0.809, 0.905 and 0.421, respectively).

Most of the prostheses (73%) were hybrid (cemented femoral stem with uncemented acetabular cup), followed by cemented (14%) and uncemented (13%) prostheses.

Regarding the femoral offset, 78% was high offset and only 22% was standard, the predominant size of the head was 32 mm (65.4% of cases), followed by 28 mm (17 .3%) and the 36mm (16.4%). There was a single 22mm-diameter head.

When evaluating the position of the acetabular cup, the average inclination was 43.39° (standard deviation [SD] 8.13) and the average anteversion was 15.16° (SD 8.80). (Table 2).

When the different variables were correlated, the anterolateral approach was associated with a more vertical cup (mean 48.42°) than the posterolateral approach (mean 41.42°), with statistical significance (p = 0.001) (Figure 2). Similarly, the anterolateral approach was associated with a more anteverse cup (16.19°; SD 9.6) versus 14.75° (SD 8.47) for the posterolateral approach, but without statistical significance (p = 0.44).

Table 2. Summary of the approaches, components and orientation of the prosthesis.

Approach	
Posterolateral	79 (72%)
Anterolateral	31 (28%)
Prosthesis type	
Hybrid	80 (73%)
Cemented	16 (14%)
Uncemented	14 (13%)
Offset	
High offset	86 (78%)
Standard	24 (22%)
Head	
22 mm	1 (0.9%)
28 mm	19 (17.3%)
32 mm	72 (65.4%)
36 mm	18 (16.4%)
Acetabular cup	
Inclination	43.39° (range 22°-75°)
Anteversion	15.16° (range 0°-42°)

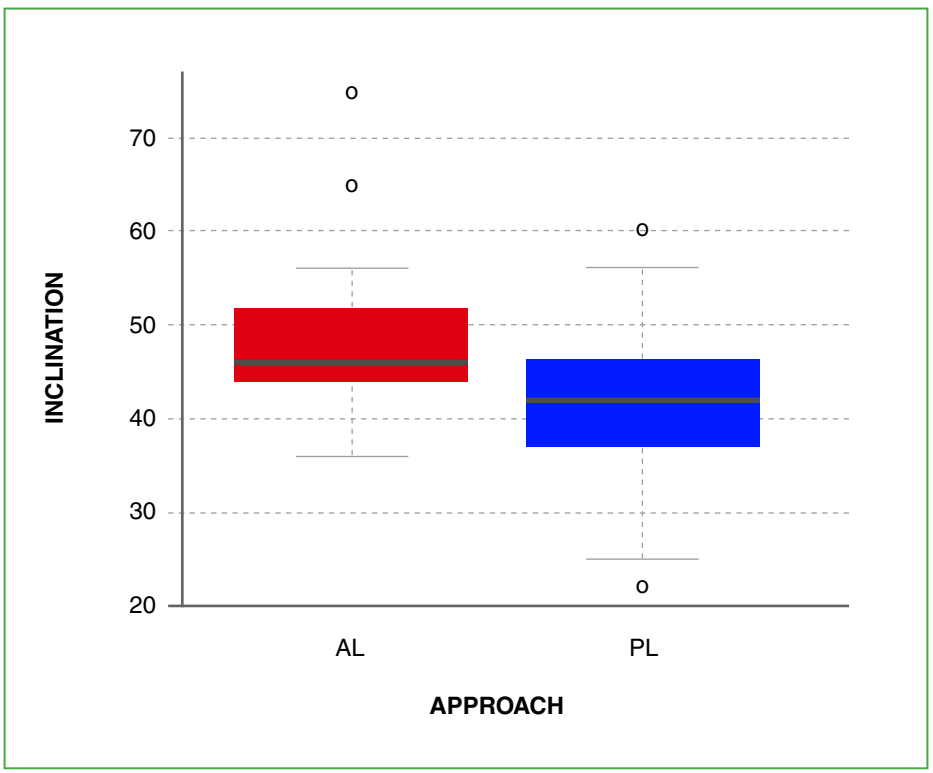

Figura 2. Statistical significance between the approach and the inclination of the acetabular cup (p = 0.001).

There were no significant differences between cup positioning and fixation type.

38% of the patients had relevant comorbidities (n = 42). The most frequent neurological comorbidities were depression, Parkinson's disease ,and Alzheimer's disease (all of these patients were under neurological or psychiatric treatment). Rheumatoid arthritis was the most common rheumatologic disease (5.45%). Four patients were receiving hemodialysis, three of them had a pathological hip fracture (Table 3).

Table 3. Patient comorbidities.

Neurological comorbidities	n = 23	Non-neurological comorbidities	n = 19
Depression	8	Rheumatoid arthritis	6
Parkinson's disease	4	Hemodialysis	4
Alzheimer's disease	3	Chronic kidney disease	2
Epilepsy	2	Breast cancer	2
Cerebrovascular accident (crural hemiparesis)	2	Multiple myeloma	1
Down syndrome + autism	1	Prostate cancer	1
Dementia	1	Pancreatic cancer	1
Lower limb paraparesis	1	Non-hodgkin's lymphoma	1
Axonal polyneuropathy	1		

Surgery-related complications are described in Table 4, excluding dislocations.

Table 4. Complications, not including dislocations.

Complications	n = 8
Pulmonary thromboembolism	1
Deep vein thrombosis	1
Acetabular loosening	1
Aseptic femoral loosening	1
Acetabular fracture + deep infection (DAIR)	1
Periprosthetic fracture (Vancouver B2)	1
Superficial infection	1
Deep infection (two-stage revision)	1

DAIR = debridement, antibiotics and implant retention

Dislocation

3.6% of the patients suffered some episode of dislocation. When correlating the dislocations with the other variables analyzed, no statistically significant differences were found in terms of age, sex, the operated side or the type of fracture. (Table 5).

Regarding the surgical approach, the four patients who suffered a dislocation were operated by the posterolateral approach; however, this was not statistically significant (p = 0.209).

No significant differences were found in the type of fixation and the offset between the dislocations. In relation to the size of the head, a significant difference was found between the groups: 15% of the small heads (22 and 28 mm) and only 1% of the large ones dislocated (p = 0.0027). No 36-mm head dislocated.

When correlating dislocations with the position of the acetabular cup, there were no statistically significant differences for inclination (p = 0.614) and anteversion (p = 0.810); however, dislocation was associated with an average 3.5° greater inclination, and one of those cups was oriented at 60°.

There were two cases of dislocation in two patients with a 28 mm head and cup with minimal anteversion (1° and 8°).

Finally, two patients had a single episode of dislocation one month after surgery: one had stage 4 Parkinson's disease, excessive acetabular anteversion (23°), and a 32-mm head. The other patient had Down syndrome with autism, an excessive acetabular inclination (60°), and a 22-mm head.

Table 5. Correlation between dislocation and the different variables.

Variables		Without dislocation (n = 106)	With dislocation (n = 4)	p
Age (years)		69.4 ± 11.7	68.3 ± 20.5	0.7192
Sex	Male	31 (97%)	1 (3%)	0.8564
	Female	75 (96%)	3 (4%)	
Side	Right	54 (96%)	2 (4%)	0.9704
	Left	52 (96%)	2 (4%)	
Garden	Types I-II	11 (100%)	0 (0%)	0.4971
	Types III-IV	95 (96%)	4 (4%)	
Approach	Anterolateral	31 (100%)	0 (0%)	0.2019
	Posterolateral	75 (95%)	4 (5%)	
Fixation	Cemented	15 (94%)	1 (6%)	0.5775
	Hybrid	78 (98%)	2 (3%)	
	Uncemented	13 (93%)	1 (7%)	
Head size	22-28 mm	17 (85%)	3 (15%)	0.0027
	32-36 mm	89 (99%)	1 (1%)	
Inclination		43.3 ± 8.1	46.8 ± 9.5	0.6145
Anteversion		15.2 ± 8.8	14.0 ± 11.3	0.8107
Comorbidities	No	71 (99%)	1 (1%)	0.0830
	Yes	32 (96%)	3 (8%)	

There was a statistically significant association between small heads and dislocation (p = 0.0027).

DISCUSSION

Risk factors for instability in THA are multifactorial and may be patient-specific, related to surgical variables (choice of approach, position of components), or related to the implant (type of fixation, femoral head diameter, retentiveness).

Instability remains one of the leading causes of hospital readmission and the leading cause of revision surgery both in the United States and in most European countries, and its economic cost after a primary THA dislocation can rise to 148%.[8] Modifications in surgical technique (eg, anterior surgical approach, posterior soft-tissue repair in the posterior approach, restoration of abductor tension, and incorporation of larger diameter femoral heads) decrease the risk of postoperative instability after a THA.

Many patient-related factors are associated with a higher risk of dislocation, including female gender, older age, prior hip surgery, neuromuscular and cognitive disorders, excessive alcohol use, abductor weakness, surgical approach, malpositioning of the components, failure to restore leg length, preservation of the abductor mechanism, capsular repair, femoral-acetabular impingement, and surgeon experience.[5]

In the literature, there is no agreement regarding age as a predisposing factor for dislocation. Byström et al.[9] stated that patients >80 years of age had a 4.5 times higher risk of suffering a dislocation, while Berry[10] reported that, in people >70 years of age, the risk was 1.3 times higher. In our study, there were no significant differences when analyzing the relationship between age and dislocation episodes.

There is much evidence that, in the posterolateral approach, the repair of the posterior muscle plane and capsule provides more prosthetic stability. In a study of patients with femoral neck fractures treated with THA by the posterolateral approach, Kwon et al.[11] reported a 14% incidence of dislocations in the group without posterior plane repair and 12% in those with repair. Posterior plane repair increases stability and the need for more force to reach the dislocation of the prosthesis.[12] Mufarrih et al.[5] recommend implementing the anterolateral approach as standard practice for patients at a higher risk of dislocation, including those with a femoral neck fracture. In our series, all the dislocations occurred in patients operated by the posterolateral approach, but this did not have statistical significance.

Two implant-related risk factors are femoral head size and head-neck ratio, which may be more modifiable than the patient-related factors already listed.

In randomized controlled trials, larger femoral heads ≥36mm have resulted in a lower incidence of dislocation on both primary and revision THA, but should be used with caution as larger diameter heads have more volumetric wear, which should be taken into account, especially in young patients (<70 years).

The dual mobility joint combines the "low friction" principle with a 22-mm diameter head, popularized by Charnley with the McKee-Farrar concept of using a larger diameter femoral head to improve stability. The objective of the dual articulation is to achieve the greatest possible range of motion by reducing wear. The polyethylene insert is made mobile within a metal cup (with mirror polished surface) with a head, also mobile in that insert, but constrained.

Some current studies show the superiority of dual mobility THA for treating displaced femoral neck fractures in patients at high risk of prosthesis dislocation.[1-3] In our Department, we do not perform any dual mobility THA in patients with displaced fractures of the femoral neck and, according to the analysis of the results, the cases of instability were due to a poor surgical technique in the orientation of the components or a poor selection of the implant in patients with a high risk of dislocation of the prosthesis (neurocognitive and psychiatric diseases).

CONCLUSIONS

Although the dislocation of a THA in patients with femoral neck fracture is due to multiple factors, small diameter heads together with poor positioning of the prosthesis and neurocognitive diseases are associated with greater instability. 36-mm diameter heads and proper component orientation are sufficient to ensure stability. However, the use of dual mobility cups could be considered when the risk of dislocation is higher (patients with neurocognitive disorders).

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

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