

Prophylactic Technique to Reduce the Risk of Interprosthetic Femoral Fractures

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ABSTRACT

Introduction: With increasing life expectancy and patient longevity, the number of hip and knee arthroplasties has risen, leading to more ipsilateral joint replacements and, consequently, a higher risk of interprosthetic femoral fractures (IFF). The objectives of this study were to evaluate fracture-free survival in patients with ipsilateral hip and knee arthroplasties who had risk factors for IFF and to assess their functional outcomes. **Materials and Methods:** Six patients with ipsilateral hip and knee arthroplasties were evaluated, all operated on by the same surgical team. The mean follow-up was 46.5 months. Risk factors for interprosthetic fractures included stemmed prostheses, advanced age, osteoporosis, distance between stems <8 cm, revision surgery, and obesity. At the time of arthroplasty, minimally invasive osteosynthesis with a locking plate was performed as a prophylactic measure. **Results:** No cases of interprosthetic fracture, infection, loosening, or revision were observed. The rehabilitation protocol was not modified. **Conclusion:** Although few studies have addressed interprosthetic fractures, and their results are heterogeneous, they consistently highlight the same risk factors. We believe that prophylactic osteosynthesis entails low intraoperative morbidity and mortality and provides satisfactory short-term outcomes.

Keywords: Interprosthetic fracture; femoral fracture; prophylaxis.

Level of Evidence: IV

Método profiláctico para disminuir el riesgo de fracturas interprotésicas femorales

RESUMEN

Introducción: Como consecuencia de la mayor expectativa de vida y la longevidad de los pacientes, han aumentado las artroplastias de rodilla y cadera y, por lo tanto, el número de artroplastias ipsilaterales. Esto determina un mayor riesgo de sufrir una fractura interprotésica. Los objetivos de este estudio fueron evaluar la supervivencia libre de fractura interprotésica femoral en pacientes sometidos a artroplastias ipsilaterales de cadera y rodilla, y con factores de riesgo, y analizar su evolución funcional. **Materiales y Métodos:** Se evaluó a 6 pacientes con artroplastias ipsilaterales de cadera y rodilla. El seguimiento promedio fue de 46.5 meses. Los factores de riesgo de fracturas interprotésicas eran: prótesis con vástagos, edad avanzada, osteoporosis, distancia entre vástagos <8 cm, revisiones y obesidad. Se les realizó una osteosíntesis mínimamente invasiva con placa bloqueada en el momento de colocar la prótesis. **Resultados:** No hubo casos de fracturas interprotésicas, infección, aflojamiento o revisión. No se modificó el protocolo de rehabilitación. **Conclusiones:** Hay pocos artículos sobre fracturas interprotésicas y los resultados son dispares, pero coinciden respecto de los factores de riesgo para que se produzcan. Creemos que la técnica de profilaxis con osteosíntesis supone una baja morbilidad en el acto intraoperatorio y logra resultados satisfactorios a corto plazo.

Palabras clave: Fractura interprotésica; fractura femoral; profilaxis.

Nivel de Evidencia: IV

INTRODUCTION

Interprosthetic femoral fractures (IFFs) occur in the femoral segment located between a total knee arthroplasty and a total hip arthroplasty. This type of fracture was first described by Dave et al. in 1995.¹ Owing to the excellent results achieved with hip and knee arthroplasties, the number of IFFs has increased notably. In the United States, more than 700,000 total knee arthroplasties and 300,000 total hip arthroplasties are performed annually, and the reported incidence of IFFs ranges from 2.5% to 5.5%.^{2,3}

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Published risk factors include advanced age, revision arthroplasty, uncemented stems, rheumatoid arthritis, distance between stems <11 cm, osteoporosis, obesity, and female sex.⁴ These fractures are classified according to the Pires and Platzer system.⁵⁻⁷

Different treatment algorithms have been established for periprosthetic femoral fractures, but there is no specific predetermined treatment for IFFs.⁸ Various studies have shown that IFFs are a devastating complication in patients with ipsilateral arthroplasties. Neitzke et al. reported a 24% reoperation rate and a 71% reintervention-free survival at 2 years, underscoring the clinical impact of this entity.⁹

The lack of a treatment standard, together with poor outcomes, prompted the search for a prophylactic method to reduce fracture risk and improve the prognosis of this complex condition. Placement of an osteosynthesis construct at the zone of highest stress has been described as a prophylactic method to decrease fracture incidence.

The objectives of this study were to evaluate IFF-free survival in patients with ipsilateral hip and knee arthroplasties and risk factors, and to analyze their functional course.

MATERIALS AND METHODS

In this retrospective study, six patients who had undergone ipsilateral hip and knee arthroplasties were evaluated. Four were men and two were women. Mean age was 76.8 years (range, 63–86). Inclusion criteria were ipsilateral hip and knee arthroplasties plus at least two of the following risk factors: age >70 years, diagnosed osteoporosis, distance between stems <8 cm, prior prosthetic revision, obesity (body mass index >30), and uncemented stems. Exclusion criteria were prior fractures of the ipsilateral femur, active infection, or follow-up <12 months.

At the time of prosthesis placement, minimally invasive prophylactic osteosynthesis was performed using a fixed-angle locking plate, secured with bicortical screws, unicortical locking screws, and wire cerclage. In two cases, a second medial support plate was added. All patients were operated on by the same team; mean follow-up was 46.5 months (range, 27–70).

Patients were assessed at 2, 6, and 12 weeks; 6 months; 1 year; and 2 years. Panoramic femoral radiographs were obtained for follow-up. Function was assessed with the *Harris Hip Score* (HHS) in cases whose latest implant was a hip arthroplasty and with the *Knee Society Score* (KSS) for patients who underwent knee arthroplasty (Table 1).

Table 1. Risk factors for interprosthetic fracture

Patient	Gender	Age (years)	Osteoporosis	Distance between stems (cm)	History of revision prosthesis	BMI (kg/m ²)
1	F	83	Yes	12	Hinged TKA	32
2	M	80	No	10	Hinged TKA	38
3	M	86	No	3	Revision TKA	28
4	M	81	No	4	Revision THA Cemented stem	35
5	F	63	Yes	0	Revision THA Distal fixation stem	30
6	M	68	No	8	Revision THA Distal fixation stem	33

F = female; M = male; BMI = body mass index; TKA = total knee arthroplasty; THA = total hip arthroplasty.

RESULTS

Three patients had undergone total hip arthroplasty: two with a primary hybrid prosthesis and one with a revision prosthesis with a cemented stem; all had ipsilateral knee implants with cemented stems (Figures 1 and 2). In addition to the hip implant, a prophylactic lateral osteosynthesis plate was placed in all three. Preoperative HHS was 45 (range, 42–48) and postoperative HHS was 80.33 (range, 79–82).

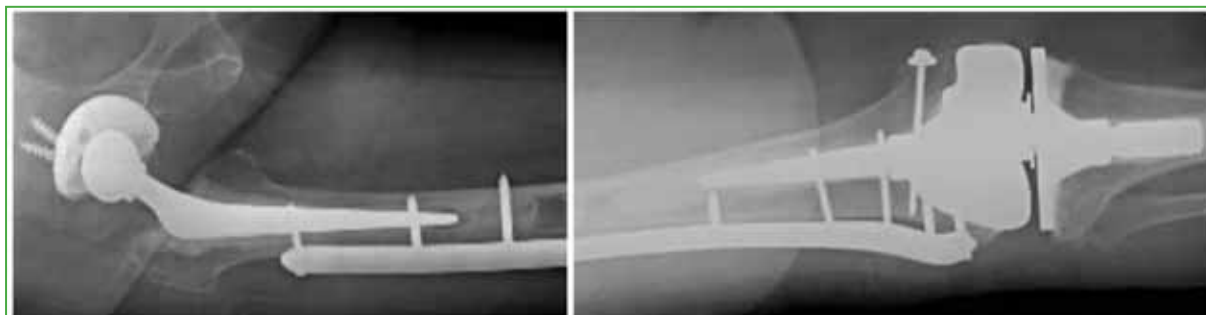


Figure 1. Eighty-year-old patient who underwent a hybrid total hip replacement for osteoarthritis, with a prior ipsilateral hinged total knee replacement, and prophylactic lateral plate placement.



Figure 2. Eighty-three-year-old patient with osteoporosis, treated in the same manner as the patient in Figure 1.

The remaining three patients underwent knee prosthesis revision: two with a hinged prosthesis with cemented stems and one with an posterior-stabilized prosthesis with cemented stems. These patients already had ipsilateral hip implants at the time of knee revision; all were hip revisions, one with a cemented stem and two with uncemented, distally fixing stems. In two patients, a double prophylactic plate (lateral and a medial support plate) was placed during the same knee revision procedure (Figure 3).

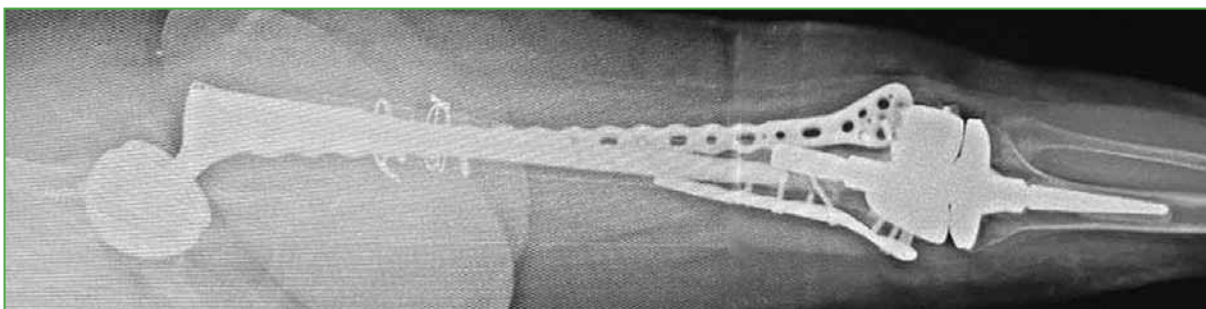


Figure 3. Sixty-three-year-old patient with a right hip revision using a distally fixing stem who underwent an ipsilateral knee revision with a hinged prosthesis and double prophylactic plating (lateral and medial).

In the remaining patient, only a lateral plate was placed. Preoperative KSS was 44.66 (range, 40–48) and post-operative KSS was 82.33 (range, 77–87) (Table 2).

No patient experienced complications and, notably, no interprosthetic fractures were recorded. One patient died at 37 months of follow-up from causes unrelated to the surgery.

Table 2. Results

Patient	Treatment	Pro-phylactic plate	Preoperative HHS	Post-operative HHS	Pre-operative KSS	Post-operative KSS	Follow-up (months)	Inter-prosthetic fracture
1	Hybrid THA	Yes Lateral	42	80	N/A	N/A	70	No
2	Hybrid THA	Yes Lateral	48	82	N/A	N/A	48	No
3	Revision THA Cemented stem	Yes Lateral	45	79	N/A	N/A	45	No
4	Hinged revision TKA	Yes Double plate	N/A	N/A	40	87	52	No
5	Hinged revision TKA	Yes Double plate	N/A	N/A	46	77	37	No
6	Revision TKA	Yes Lateral	N/A	N/A	48	83	27	No

HHS = Harris Hip Score; KSS = Knee Society Score; THA = total hip arthroplasty; TKR = total knee arthroplasty; N/A = not applicable.

DISCUSSION

Despite growing interest in the epidemiology, management, and outcomes of interprosthetic fractures, the literature remains limited. Interprosthetic fractures are uncommon; consequently, publications on this condition are scarce. They typically occur in older adults, are more frequent in women, and almost always result from low-energy mechanisms.^{10,11} They are associated with the presence of hip and knee implants and, in some series, occur more often at the supracondylar level, a pattern linked to constrained implants.¹² More than 20 years ago, Kenny et al. noted that IFFs are difficult to treat.^{13,14} Currently, treatment is associated with multiple potential complications arising from poor bone quality, prosthetic obstacles, residual bone defects, or prosthesis loosening. In at-risk patients, outcomes range from poor to catastrophic.¹⁵ In recent years, locking plates have gained popularity because of biomechanical and biological advantages over nonlocking constructs.^{16,17} Angular stable plates provide better fixation than conventional plates in osteoporotic bone. Some authors also advocate intramedullary nailing.¹⁸

Among the risk factors described, the distance between implants alone does not fully predict fracture risk; shorter distances increase stress-zone fracture risk, whereas overlap between implants has been associated with reduced fracture rates.^{19,20}

Multiple biomechanical studies have shown that femoral cortical thickness is a predominant and independent risk factor for IFFs, even more so than the interstem distance. Weiser et al. evaluated human cadaveric femurs and found a significant correlation between cortical thickness and bone strength ($r = 0.804$, $p < 0.001$), with neither interprosthetic distance nor bone mineral density exerting a relevant influence on fracture occurrence.²¹ Likewise, Mühling et al. confirmed via physical and computational simulations that thin cortices generate sig-

nificantly higher stress peaks, increasing fracture risk, whereas thick cortices mitigate the effect of close implant proximity.²² These findings reinforce the need to consider cortical thickness as a key parameter in surgical planning and in preventing interprosthetic fractures.

Although this is an infrequent complication with high morbidity and mortality, we found no references in the literature to preventive methods specifically for IFFs.²³ Options include using short hip stems to increase the interstem gap; inserting cement between stems (long stems in a “kissing” configuration with interposed cement), although cement retainers may form and mark a zone of weakness; or placing a structural cortical onlay allograft, which we consider valid but which requires a larger exposure for placement and fixation, further devitalizes soft tissues, and carries a risk of bone resorption.^{24,25}

By contrast, placing a long plate fixed with locking screws, cortical screws, and/or cerclage wire is a method with which we are very familiar. It does not substantially prolong operative time or increase comorbidities, avoids severe complications, and does not alter the usual rehabilitation protocol after conventional arthroplasty.

Using proximal cables increases fixation without interfering with prosthesis placement; creating femoral loops does not cause periosteal injury because contact points are discrete.^{26,27} Moreover, angular locking systems do not require intimate plate-bone contact; periosteal injury and subplate bone resorption are therefore clearly reduced. Kampshoff et al. showed that using either unicortical or bicortical screws in the presence of cement does not compromise prosthesis fixation and that bicortical screws achieve better fixation.²⁸

Unlike Neitzke et al., for whom treatment of IFFs involved complex operations with high rates of infection and nonunion, our series proposes a preventive strategy (prophylactic osteosynthesis) in patients with defined risk factors. With this minimally invasive intervention, we achieved 100% fracture-free survival over follow-up, with no surgical or functional complications. Both studies identify the presence of stems and interprosthetic distance as critical biomechanical factors; however, whereas Neitzke et al. address established fractures, our approach seeks to prevent their occurrence through early intervention.⁹

With this technique we achieved excellent results: a reduced incidence of fractures in at-risk patients, minimal soft-tissue insult, and a stable construct that allows early weight bearing. A study with greater statistical power is needed to evaluate the protective effect of the procedure.

Limitations of this study include the small sample size, its retrospective design with prospective data collection, and the absence of a control group. Strengths include the paucity of literature on prevention of this fracture pattern—making this an original contribution—and that all patients were operated on by the same surgical team.

This preliminary study suggests that prophylactic osteosynthesis using a locking plate in patients with ipsilateral hip and knee arthroplasties and risk factors for IFFs may be an effective strategy to reduce the incidence of this complication.

CONCLUSIONS

In our cohort, IFF-free survival was 100% during follow-up; no surgical complications occurred and the rehabilitation protocol was not altered. In addition, functional outcomes assessed with HHS (hip) and KSS (knee) were satisfactory, with clinical improvement in all cases.

Complementing these findings, current publications highlight femoral cortical thickness as a predominant and independent risk factor, even above interstem distance. This reinforces the need to incorporate bone structural parameters into surgical planning, especially in patients with multiple implants and compromised bone. While acknowledging this study's weaknesses, we consider that it provides original evidence on a reproducible, low-morbidity preventive technique with potential to improve prognosis in high-risk patients. Multicenter studies with greater statistical power are required to validate these results and establish universal recommendations.

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

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