Treatment of types B2 and B3 peri-prosthetic fractures with distal fixation non-cemented stems

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Abstract

Introduction: Peri-prosthetic fracture is the third cause in frequency in hip revision following aseptic loosening and infection. The ones that show associated with a loosened stem (B2) or a bone stock deficit (B3) should receive femoral revision.
Materials and Methods: We studied retrospectively 38 patients with types B2 and B3 femur peri-prosthetic fracture treated with distal fixation non-cemented stems with neither bone graft nor osteosynthesis plates. Average follow-up was 2.5 years (range 1.5-10).
Results: The average score in the Harris Hip Score was 69 (range 57-91). There was bone healing in all cases. Survival free from revision was 94.8%. Complications were: one (2.6%) >5 mm stem subsidence, one (2.6%) dislocation, two (5.2%) infections and one (2.6%) wound hematoma. **Conclusion:** Revision techniques with distal fixation non-cemented stems with no bone graft have proved to be effective methods for the treatment of types B2 and B3 hip peri-prosthetic fractures.

Key words: Peri-prosthetic fractures; femoral revision; non-cemented stem
Level of evidence: IV

Tratamiento de las fracturas periprotésicas de cadera de tipos B2 y B3 con tallos no cementados de fijación distal

Resumen

Introducción: La fractura periprotésica es la tercera causa más frecuente de revisión de cadera por detrás del aflojamiento aséptico y la infección. Aquellas que se presentan asociadas a un tallo flojo (B2) o a un déficit de capital óseo (B3) deben ser tratadas con la revisión femoral.
Materiales y Métodos: Se estudiaron retrospectivamente 38 pacientes con fracturas periprotésicas de fémur de tipos B2 y B3 tratadas con tallos no cementados de fijación distal sin injerto óseo ni placas de osteosíntesis. El tiempo de seguimiento promedio fue de 2.5 años (rango 1.5-10).
Resultados: El puntaje promedio en el *Harris Hip Score* fue 69 (rango 57-91). En todos los casos, se logró la consolidación ósea. La supervivencia libre de revisión fue del 94,8%. Las complicaciones fueron: un (2,6%) hundimiento del tallo >5 mm, una (2,6%) luxación, dos (5,2%) infecciones y un (2,6%) hematoma de la herida.
Conclusión: La técnica de revisión con tallos no cementados de fijación distal sin el aporte de injerto óseo ha demostrado ser un método eficaz para tratar las fracturas periprotésicas de cadera de tipos B2 y B3.

Palabras clave: Fractura periprotésica; revisión femoral; tallo no cementado.
Nivel de Evidencia: IV

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Introduction

The number of hip arthroplasties is on the increase and, consequently, the number of revisions is. According to Swedish Medical Records, peri-prosthetic fractures are the third ones as the most frequent ones causing hip revision, following aseptic loosening and infection.[1] The management of these fractures is complex and, in general, they are associated with high morbidity[2] and mortality[3] rates. The Vancouver Classification for peri-prosthetic femoral fractures, developed by Duncan and Masri in 1995 is the most accepted due to its handiness at the time of deciding treatment.[4] According to this classification, the surgeon can resort to different therapeutic options on the grounds of the fracture location, implant stability and the remaining bone stock. There is general agreement on the indication of open or closed reduction plus internal fixation[5,6] for most of the fractures associated with fixed implants (type B1). On the contrary, fractures associated with a loosed stem (type B2) should be treated with stem revision.[7-10] Finally, fractures associated with a loosened stem and scarce remaining bone stock (type B3) historically have been treated with resection prosthesis of the proximal femur [11,12] or alloprosthesis.[13] More recently, distal fixation non-cemented stems have also got good results in this group of fractures.[14-16]

In this study we report our experience in the treatment of femoral peri-prosthetic fractures types B2 and B3 with long non-cemented stems fixed in the diaphyseal fragment distal to the fracture and osteosynthesis of the proximal fragments, either fractured or osteotomized, with wire or cable looping around the proximal part of the prosthesis with neither allograft sheets nor osteosynthesis plates.

Materials and Methods

Between 2000 and 2014 we treated 38 patients with femoral peri-prosthetic fracture types B2 and B3 of the Voncouver Classification. They averaged 73.7 years old (ranging from 55 to 91). Eighteen (47%) patients were females, whereas twenty (53%) were males. Average time since the primary surgery to the peri-prosthetic fracture was 7 years (ranging from 0.5 to 20). Primary arthroplasty was cemented in 20 (53%) cases; hybrid in 10 (26%), non-cemented in 6 (16%), and two patients received cemented partial arthroplasty. With respect to the type of peri-prosthetic fracture, 26 (68.5%) were classified as type B2, 10 (26%) as type B3, and two (5.5%) were non-unions previously treated as fractures type B1 in other centers.

All the patients were pre-operatively evaluated with an anterior-posterior bilateral hip X-ray and anterior-posterior plus lateral X-rays of the affected femur. ESR and CRP were used to rule out infection.

In all cases stems were distal fixation non-cemented ones: 24 (63%) modular tapered stems, 10 (26%) non-modular cylindrical stems, two (5.5%) modular cylindrical stems and two (5.5%) non-modular tapered stems. In 21 cases (55%), we carried out revision of the cup component. In 12 (57%) of them, we used a non-cemented cup component, in two (9%) we changed the insert and, in six (29%), due to the rupture of the capture mechanism or lacking the original insert we used the technique of insert cementation into the in-grown cup metallic component.[17] In one case (5%), we used a Kerboul cup component ring (Table).

Patients were evaluated both medically and radiologically on a monthly basis up to post-operative month 4, and then at month 6 and one year after the surgery. Thereafter, follow-up was once a year. Bone healing was defined as one bone bridge across the fracture or osteotomy line in three out of four cortexes.[7] Stem subsidence was assessed from the prosthesis shoulder to the most medial part of the lesser trochanter as described by Melchay et al.[18] When there was no lesser trochanter or it could not be seen, we used a wire loop as reference. We defined loosening as >5mm stem subsidence.[15]

Medical evaluation was carried out using the Harris Hip Score.[19]

Surgical technique

We administered cephazolin 2g as antibiotic prophylaxis and trenaxemic acid 15mg/kg during anesthetic induction plus a second dose 3 hours later. All the patients were operated on in lateral position using a posterior-lateral approach. For hip dislocation, since there was no continuity between the proximal fragment and the distal femur, we used a bone hook or a *davier* under the prosthesis neck. We performed osteotomy of the proximal femur protracting the fracture line upwards on the sagittal plane or, in the case of transverse fracture, we performed extended trochanteric osteotomy as described by Paprosky.[20] This way, removal of the stem and cement, if any, as well as socket exposition are facilitated. The cup component was revised in this moment when it was necessary. Afterwards, ignoring the proximal fragment what follows is to get to the distal canal to start preparing it with timely reamers to get the desired stability. If necessary, fluoroscopic assistance can be used to make sure there is adequate cortex contact. With non-modular stems, while reaming and introducing the implant we used the anatomic references available to determine adequate length and anteversion. With modular stems, we tried the different metaphyseal options until getting optimal length and stability. Once the definite stem is implanted what follows is reduction and stabilization of the proximal fragment around the stem using two or three wire loops. If available, we used the cup or femoral canal reamed bone as graft over the fracture line. In no case did we use structural bone or osteosynthesis plates.

The post-operative protocol consisted of partial weight bearing walk with two crutches during 6-8 weeks and, afterwards, progressive weight bearing as tolerated.

Table. Patients' data and characteristics

Case	Age	Post-operative years	Previous surgery	Vancouver	Stem	Cup component revision	Complications
1	82	10	RTCc	B3	CNM		
2	86	8	RTCc	B3	CiNM		
3	63	6	RTCh	B2	CiNM	Insert cementation	
4	77	4	RTCh	B2	CiNM		
5	77	4	RTCc	B2	CiNM	Non-cemented	DVT
6	70	13	RTCc	B2	CM	Non-cemented	DVT
7	66	6	RTCh	B1 PS	CiNM		
8	78	20	RTCnc	B3	CiNM	Insert cementation	
9	71	6	RTCc	B3	CiM	Non-cemented	Acute infection
10	76	1	RTCc	B1 PS	CM		Subsidence
11	76	11	RTCh	B2	CiM	Non-cemented	
12	78	10	RTCh	B2	CNM		
13	73	15	RTCnc	B2	CiNM	Insert cementation	
14	73	5	RTCc	B2	CiNM		
15	57	6	RTCc	B2	CiNM	Non-cemented	
16	74	10	RTCc	B2	CM	Insert cementation	
17	79	3	RTCh	B2	CM		
18	84	5	RTCc	B2	CiNM		
19	68	1	RTCh	B2	CM	Liner change	
20	78	2	RTCc	B2	CM		
21	78	4	RTCc	B2	CM	Insert cementation	
22	74	2	RTCnc	B2	CM		
23	81	8	RTCc	B3	CM		
24	81	4	RTCc	B3	CM		
25	58	0,5	RTCnc	B2	CM		
26	83	4	RTCh	B2	CM	Insert cementation	Dislocation
27	91	5	RPC	B3	CM		
28	55	3	RTCnc	B2	CM		Hematoma
29	87	12	RTCc	B2	CM	Ring	
30	73	11	RTCc	B3	CM	Non-cemented	
31	74	6	RTCc	B3	CM	Non-cemented	
32	80	14	RTCh	B3	CM	Non-cemented	
33	80	6	RTCc	B2	CM		
34	41	16	RTCc	B2	CM	Non-cemented	
35	60	6	RTCnc	B2	CM	Liner change	
36	77	5	RTCc	B2	CM	Non-cemented	Chronic infection
37	77	4	RPC	B2	CM	Non-cemented	
38	66	10	RTCh	B2	CM	Non-cemented	

cTHR= cemented total hip replacement; hTHR= hybrid total hip replacement; ncTHR= non-cemented total hip replacement; PHR= partial hip replacement; NMT: non-modular tapered; MT= modular tapered; NMC= Non-modular cylindrical; MC= modular cylindrical; DVT= deep veous thrombosis

Results

All the patients were medically and radiologically assessed during 2.5 years on average (ranging from 1.5 to 10). The average score in the Harris Hip Score was 69 (ranging from 57 to 91). We got bone healing in all cases. One stem (2.6%) showed >5 mm subsidence; however, the patient refused revision surgery because there was neither perception of walk limitation due to limb shortening nor there were instability symptoms. Another patient (2.6%) suffered two dislocation episodes three months after the surgery, which, being a modular stem, were resolved with mere revision of the metaphyseal femoral component; results were good by the last follow-up. There were two (5.2%) infections: one acute infection treated favorably with surgical toilet, antibiotics and implant retention; and a chronic infection that required a two-time revision. One patient (2.6%) showed a wound hematoma with persistent bleeding; we performed drainage and surgical toilet with good results. Two patients (5.2%) suffered deep venous thrombosis. This way, in our series stem survival free from revision is 94.8% at 2.5 years. However, it is worth mentioning that, had the patient that suffered >5 mm subsidence been revised, stem survival free from revision would be 92.2% (Figures 1-6).

Figure 1. Case 17. 79 year-old female with hybrid total hip replacement carried out 3 years before for femoral neck fracture. Fall from standing height. Type B2 peri-prosthetic fracture. ASA 3.

Discusion

At the time of treating femoral peri-prosthetic fractures, the aims are bone healing as anatomically as possible and prosthesis stability that allow patients early motion and activity levels similar to those previous to the fracture.[14] The Vancouver Classification has proved to be handy at the time of determining treatment. However, the incorrect interpretation of X-rays can put treatment results at stake if a type B2 fracture is classified as a type B1 fracture. Lindhal et al.[8] analyzed results in 1049 peri-prosthetic fractures and found failure rates of 59% in the group of type B1 fractures treated with osteosynthesis vs. 12% in the group of type B2 fractures treated with implant revision. The authors concluded that the high failure rates in the group of patients with fractures that theoretically occurred in a stable stem is due to the incorrect interpretation of a type B2 fracture as a type B1 fracture; therefore, they suggest that doctors should indicate stem revision when in doubt with respect to stem stability.

There is general agreement on implant revision in fractures associated with types B2 and B3 loosed stem.[7-10,14,15,21-23] However, there have been reports on different techniques both in non-cemented implants and cemented implants with or without bone graft. The goal is femoral revision with a stem that exceeds, at least in 2 diaphysis diameters, the fracture and the osteosynthesis of the proximal fragment. Several authors have pointed at the

Figure 2. Case 17. Patient subject to femoral prosthetic revision with modular tapered stem and osteosynthesis of the proximal fragment with wire looping. Immediately post-operative check-up.

Figure 3. Case 17. 11-month post-operative follow-up. Stable stem following <5 mm subsidence. Bone healing. Harris Hip Score 82.

Figure 4. Case25. 58 year-old male with type B2 femoral peri-prosthetic fracture due to motorcyle crash. Total hip replacement six months before.

Figure 5. Case 25. Femoral revision with modular tapered stem. Immediately post-operative check-up.

Figure 6. Cas2 25. Two years after the surgery. Bone healing. Harris Hip Score 91.

presence of cement in the fracture line as the reason for the high rates of early loosening and lack of bone healing associated with cemented stem techniques. In 1996, Beal et al.[24] reported a series of 102 peri-prosthetic fractures and 62% of complications with cemented stems, what includes early loosening, lack of bone healing, dislocation and infection.

Due to the bad results associated with cemented stems, nowadays there are new tendencies towards distal fixation non-cemented stems. The main advantage of non-cemented stems is the possibility of getting distal fragment stability independently of whatever proximal bone defect. The long-term success of fixation with extensively porous-coated cylindrical stems depends on 4-6 cm intimate contact between the cylindrical stem and the diaphyseal bone.[25] In 2001, MacDonald et al. reported a series of 14 type B2 fractures treated with porous-coated cylindrical stems. All of them healed. One stem showed stable fibrous fixation, but it was not necessary to revise it.[10] Springer et al. in 2003 reported a series of seven cases of type B1 fractures, 76 type fractures B2 and 35 type B3 fractures. The implants were: long cemented stems in 42 hips, extensively porous-coated non-cemented stems in 30 hips, proximally porous-coated stems in 28 hips, alloprosthesis in 14 hips, and tumor prosthesis in 4 hips. The main complications were loosening and lack of bone healing. The best results were those of extensively porous-coated non-cemented stems.[9]

The other alternative to non-cemented distal fixation, initially widespread in Europe, is that of tapered stems. Due to their striated conic design, these ones allow the surgeon to get minimal femoral diaphyseal fixation of 4 cm.[26] In 2003, Berry et al. reported a series of eight patients with type B3 fractures treated with modular striated tapered non-cemented stems. All of the fractures healed and no stem had to be revised by final follow-up.[16] In 2005, Mulay et al. published a series of 24 type B2 and B3 peri-prosthetic fractures treated with tapered stems and no bone graft. Two patients were lost to follow-up. Bone healing occurred in 20 out of 22 cases. Average stem subsidence was of 5 mm by post-operative month 6. Five patients underwent dislocation, two of which required revision. Moreover, there was one case of infection.[14] In 2012, Neumann et al. reported a series of 55 peri-prosthetic fractures (35 type B2 fractures and 20 type B3 fractures) treated with a modular tapered stem and no bone graft. All the patients showed bone healing; two patients (4%) underwent >5 mm stem subsidence and required femoral revision.[15] Due to the excellent results achieved with distal fixation non-cemented stems, even in cases with severe bone stock deficit, nowadays many surgeons consider them to be the first therapeutic alternative for types B2 and B3 fractures and spare alloprosthesis or proximal femur replacement prosthesis for the most extreme cases.[14-16,23,26] As additional advantage, some authors have pointed out proximal bone stock recovery in hip revision with striated tapered stems.[14,16,18] Although we have not carried out systematic revision of bone density throughout follow-up, with striated tapered stems we have not seen remarkable loss of proximal bone stock as we did with extensively porous-coated cylindrical stems.

Although our study is based on a uniform series of patients with types B2 and B3 femoral peri-prosthetic fractures, all them treated with distal fixation non-cemented implants with neither bone graft nor osteosynthesis plates, we acknowledge some limitations. First of all, it is a retrospective series without control group with average short-term follow-up of 2.5 years. Secondly, the type of stem used changed throughout the series. Initially, modular striated tapered stems were spared for the cases in which, due to the type of fracture or because of bone stock deficit, there were not minimal 4 cm of adequate distal femoral diaphysis for stable fixation of extensively porous-coated cylindrical stems. Towards the end of the series follow-up, however, in the prescription of modular striated tapered stems we included all the patients with types B1 and B2 peri-prosthetic fractures, what coincides with our general prescription in revision—we find modularity particularly useful in these complex situations.

Conclusions

The correct interpretation of X-rays, particularly with respect to the implant stability, is essential to decrease the likelihood of therapeutic failure. If in doubt, we believe it is necessary to carry out femoral revision. Revision techniques with distal fixation non-cemented stems associated with osteosynthesis of the proximal fragment with wire or cable looping, with neither bone graft nor osteosynthesis plates, have proved to be an effective method for the treatment of types B2 and B3 hip peri-prosthetic fractures.

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