Revision Surgery: Cemented Monoblock Stem Following Failure of Osteosynthesis in Extracapsular Hip Fractures

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ABSTRACT

Introduction: This study presents our experience with revision surgery using total hip arthroplasty with a dual mobility acetabular cup and a cemented stem as a treatment for failed osteosynthesis in extracapsular fractures. **Materials and Methods:** A series of 38 patients operated on by the same surgical team between January 2015 and December 2022 was evaluated. Demographic data and variables related to the patients' clinical evolution up to their last follow-up after revision surgery were collected. Functional outcomes were assessed using the Harris Hip Score, the Barthel Index, and the Visual Analog Scale (VAS). Radiological outcomes were analyzed using the Brooker and Paprosky classifications. Procedure-related complications were also recorded. **Results:** The mean patient age was 81.4 years, with an average follow-up period of 28 months. The mean time from osteosynthesis to revision surgery was 6.5 months. The most frequent femoral defects were classified as Paprosky grades I and IIA. The mean scores achieved were 86.2 (range: 65–96) on the Harris Hip Score, 91.2 (range: 70–95) on the Barthel Index, and 2.05 (range: 0–5) on the VAS. Complications included three cases of prosthetic dislocation (7.8%) and two cases of chronic infection (5.2%), both requiring surgical revision. **Conclusions:** Salvage treatment for failed osteosynthesis in extracapsular hip fractures using total hip arthroplasty with a dual mobility acetabular cup and a cemented stem demonstrates favorable clinical and functional outcomes, with high implant survival rates.

Keywords: Revision; failure; osteosynthesis.
Level of Evidence: IV

Cirugía de revisión. Vástago monobloque cementado tras el fracaso de la osteosíntesis en las fracturas extracapsulares de cadera

RESUMEN

Introducción: Presentamos nuestra experiencia en la cirugía de revisión mediante artroplastia total de cadera con cotilo de doble movilidad y vástago cementado como tratamiento ante el fracaso de la osteosíntesis en fracturas extracapsulares. **Materiales y Métodos:** Se evaluó a 38 pacientes operados por el mismo equipo quirúrgico, entre enero de 2015 y diciembre de 2022. Se recogieron datos demográficos y de variables sobre la evolución del paciente hasta el último control clínico después de la cirugía de revisión. La función se evaluó con el Harris Hip Score y las escalas de Barthel y analógica visual. Los resultados radiológicos se analizaron con las clasificaciones de Brooker y de Paprosky. Se registraron las complicaciones asociadas al procedimiento. **Resultados:** La edad media de los pacientes era de 81.4 años y el seguimiento medio fue de 28 meses. El tiempo medio desde la osteosíntesis hasta la revisión fue de 6.5 meses. Los defectos femorales más frecuentes fueron de grados I y IIA de Paprosky. El Harris Hip Score fue de 86,2 (rango 65-96); el puntaje en la escala de Barthel, de 91,2 (rango 70-95) y el de la escala analógica visual, de 2,05 (rango 0-5). Las complicaciones fueron: 3 casos de luxación de la prótesis (7,8%) y 2 de infección crónica (5,2%), que necesitaron revisión quirúrgica. **Conclusiones:** El tratamiento de rescate ante el fracaso de la osteosíntesis de fracturas extracapsulares mediante artroplastia total de cadera con cotilo de doble movilidad y vástago cementado logra resultados clínicos y funcionales con una alta supervivencia del implante.

Palabras clave: Revisión; fracaso; osteosíntesis.
Nivel de Evidencia: IV

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How to cite this article: Garrido Ferrer JF, Sánchez Losilla C, Diranzo García J, Estrems Díaz V, Hernández Ferrando L. Revision Surgery: Cemented Monoblock Stem Following Failure of Osteosynthesis in Extracapsular Hip Fractures. *Rev Asoc Argent Ortop Traumatol* 2025;90(1):7-14. https://doi.org/10.15417/issn.1852-7434.2025.90.1.1903

INTRODUCTION

According to the literature, the rate of revision surgery is projected to increase by 137% between 2005 and 2030,[1] driven by longer life expectancy and higher functional demands among patients. Likewise, primary hip arthroplasty is increasingly performed in younger patients, reducing prosthesis survival time.[2] Aseptic loosening remains the leading cause of femoral revision surgery, followed by chronic infection, periprosthetic fractures, and recurrent dislocation.[3,4] In addition to these etiologies, and despite advancements in osteosynthesis materials, surgical failure in extracapsular hip fractures is not uncommon, often necessitating both femoral and acetabular revision.[5-7]

This study focuses on an elderly patient with high functional demand despite poor bone mineral density, questionable consolidation potential, possible acetabular articular surface involvement, and a proximal femoral bone stock defect.[5,6] In this scenario, two treatment options have been considered: revision surgery through reosteosynthesis or proximal femoral replacement with a revision stem and acetabular component.[8-10]

Following the research dynamics established by our center, which previously demonstrated comparable outcomes between dual-mobility and monopolar cups,[11] as well as between cemented monoblock and modular revision stems,[12] this study aims to evaluate the medium-term outcomes of total hip arthroplasty with a dual-mobility cup and a cemented femoral stem as a treatment for osteosynthesis failure in extracapsular fractures.

MATERIALS AND METHODS

Demographic Data

A descriptive, retrospective, and analytical study was conducted on patients who underwent revision surgery following failed osteosynthesis for extracapsular hip fractures. The procedure involved a Delta TT One dual-mobility cup (Lima Corporate, Villanova di San Daniele del Friuli, Italy) and a Lubinus SPII® cemented revision femoral stem (Waldemar Link, Hamburg, Germany) between January 2015 and December 2022. All surgeries were performed by the same surgical team.

Inclusion criteria were: age >65 years and revision surgery with the studied prosthesis model performed at our institution following failed osteosynthesis. Patients were excluded if they had undergone primary surgeries for degenerative or dysplastic disease, surgeries for pathological proximal femur fractures, revision surgeries following periprosthetic fractures, or surgeries on both limbs (Figure 1). Demographic, clinical, functional, and radiological variables were recorded.

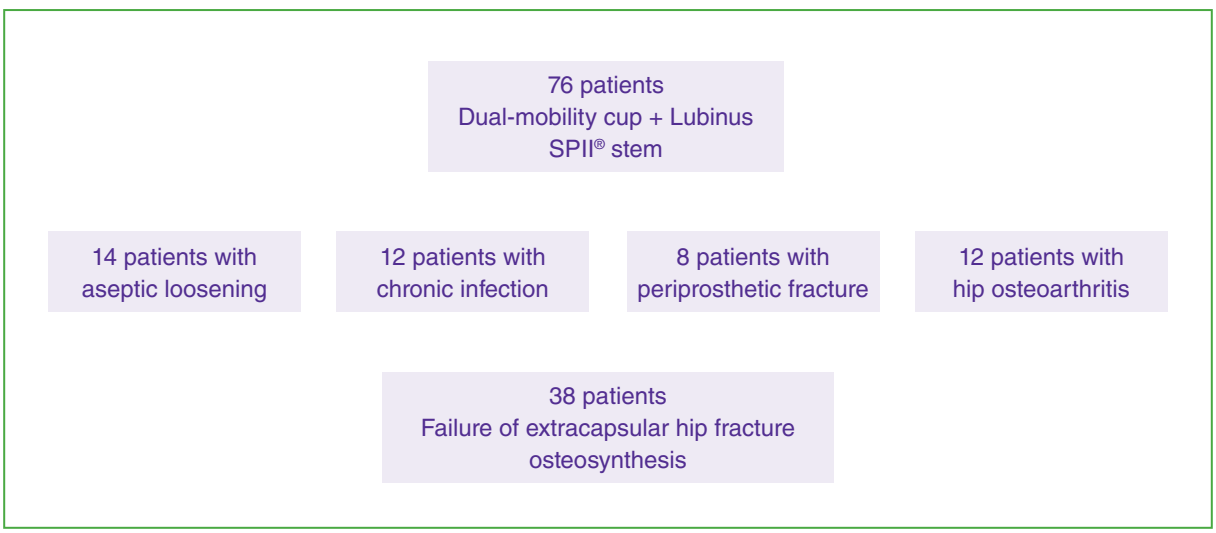

Figure 1. Diagram of inclusion and exclusion criteria.

All patients were evaluated in outpatient clinics preoperatively, postoperatively, and every three months until their final clinical follow-up. Pre- and postoperative clinical and functional outcomes were assessed using the Visual Analog Scale (VAS) and the Harris Hip Score (HHS). [13] At the last clinical follow-up, the Barthel Index was also included.[14]

Demographic variables analyzed included the number of prior surgeries, the interval between the last surgery and the current revision, surgical duration, postoperative transfusion requirements, anesthetic risk classification according to the American Society of Anesthesiologists (ASA) scale,[15] and body mass index (BMI).

The degree of femoral bone defect was assessed using the Paprosky classification[16,17] preoperatively and intraoperatively. At outpatient follow-up, heterotopic ossification was classified according to the Brooker classification[17] while femoral stem viability was evaluated using the criteria of Girard et al.[18] and Engh,[19] considering distal migration >5 mm as stem subsidence.

Surgical Procedure

Preoperative planning involved templating to determine the appropriate stem length and diameter, ensuring at least 4 cm of cortical contact and a minimum of 90% femoral canal occupation. In all cases, the femoral canal was reamed 0.5 mm smaller than the final implant diameter.

Patients received intradural anesthesia and antibiotic prophylaxis with 2 g of cefazolin or, in cases of beta-lactam allergy, 240 mg of clindamycin intravenously.

All surgeries were performed using a posterolateral hip approach. After soft tissue release, osteosynthesis material was carefully removed to minimize additional bone loss.

Trial components were used to assess both acetabular articular surface and the required stem length based on the existing bone defect. The femoral component was cemented before inserting the revision stem, resulting in a hybrid prosthesis approach in which the dual-mobility cup remained uncemented (Figure 2).

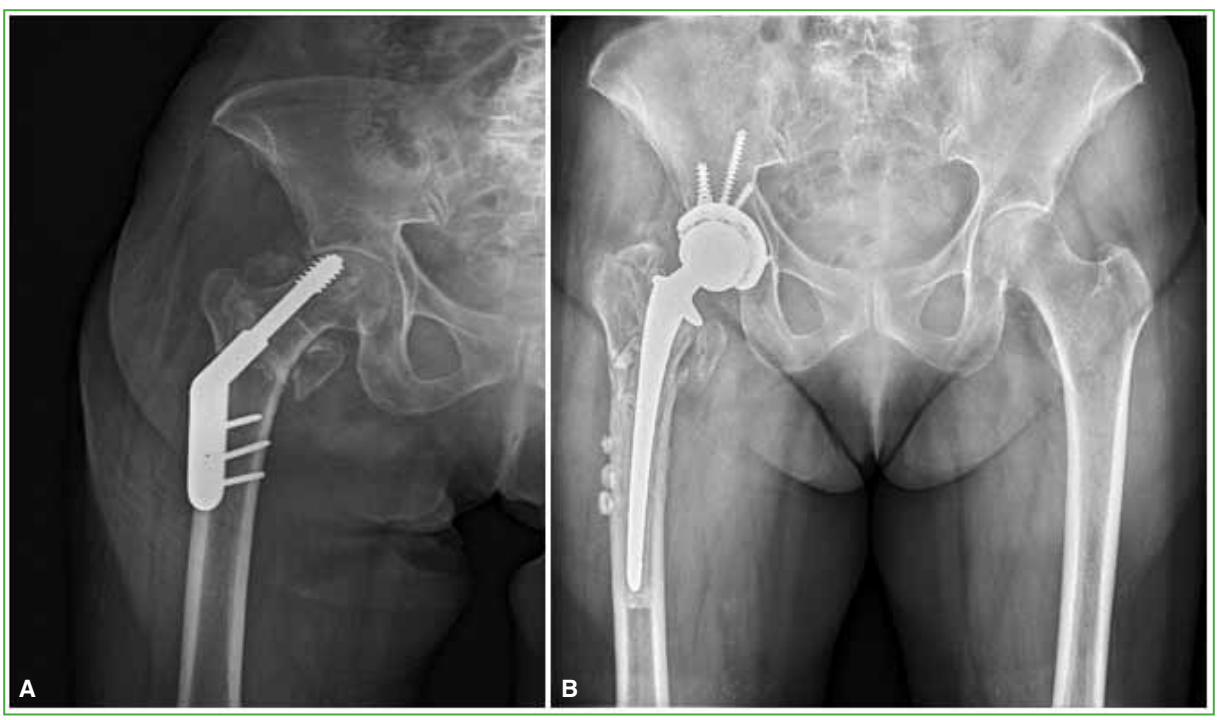

Figure 2. Anteroposterior radiographs of the pelvis. Revision surgery after failure of osteosynthesis in a hip fracture. **A.** *Cut-out* 2 months postoperatively with dynamic hip screw. **B.** Revision femoral stem and dual-mobility cup after 6 months of follow-up.

Postoperatively, isometric exercises were initiated on the first day, with assisted partial weight-bearing beginning on the second day. Patients were discharged following satisfactory clinical and functional evolution.

Statistical Analysis

Data were analyzed using SPSS 22 and XLSTAT for Windows. Categorical variables were expressed as absolute and relative frequencies, while quantitative variables were presented as means and standard deviations. Normality testing for both quantitative and qualitative variables was conducted using the Kolmogorov-Smirnov test. Comparisons between quantitative variables were performed using Student's t-test, while the χ^2 test was applied for qualitative variables. Statistical significance was set at 5%.

RESULTS

We present a series of 38 operated patients (7 men [18.4%] and 31 women [81.6%]), with a mean age of 81.4 years (range 65-100) at the time of revision surgery. Nineteen right (50%) and 19 left (50%) hips were operated on. Twenty-nine patients (74.4%) had undergone surgery only for the initial extracapsular fracture, while in 9 cases (15.6%), it was the third operation on the affected joint. None of the surgeries were bilateral.

The reason for revision surgery was failure following osteosynthesis in extracapsular hip fractures. The mean follow-up period was 28.1 months (range 12-66), and no patient was lost to follow-up. The mean length of hospitalization after surgery was 3.1 days (range 3-4).

Before surgery, 18 patients (47%) were classified as ASA II and 20 (53%) as ASA III. The mean body mass index was 28.8 (range 22-37).

The mean time between osteosynthesis failure and revision surgery was 6.5 months (range 1-26), with 84.3% of the sample undergoing surgery within three months. On the other hand, the mean surgical time was 120.1 minutes (range 90-190). In the last two years, it was reduced to less than 100 minutes, likely due to the learning curve of the surgical team. Finally, the mean postoperative transfusion requirement was 1.4 units of red blood cell concentrate (range 0-5).

Clinical Outcomes

The mean postoperative VAS score was 1.02 (range 0-5), significantly lower than the preoperative score of 7.66 (range 6-9), indicating a statistically significant clinical improvement ($p<0.02$).

Regarding functional assessment, the mean preoperative Harris Hip Score (HHS) was 58.39 (range 36-68), classified as a "poor outcome." At the last clinical follow-up, the mean HHS was 84.32 (range 65-96), indicating a "good" outcome, with statistically significant differences between pre- and postoperative scores ($p<0.001$). No significant differences were found concerning age, sex, or body mass index. However, significantly better clinical outcomes were observed in patients who had undergone only one prior surgery, had a shorter interval between osteosynthesis failure and definitive surgery, had a smaller proximal femoral defect according to the Paprosky classification, and did not experience postoperative complications ($p<0.05$).

The Barthel Index, assessed at the last clinical follow-up, was 82.63 (range 70-95), corresponding to the category of "moderate dependence." A subgroup analysis revealed statistically significant differences between patients with a postoperative VAS score ≤3 and those with a score >3. Similarly, patients with no ossifications or minimal ossifications according to the Brooker classification had higher Barthel Index scores.

Radiological Outcomes

Based on the Paprosky classification before and after surgery, 18 patients (47.7%) had a type I femoral defect, 13 (34.2%) had a type IIA defect, and 7 (18.4%) had a type IIB defect (Table). Regarding femoral defects, the longest femoral stem (170 mm) was used in 20 patients (52.6%), the medium-sized stem (150 mm) in 12 patients (31.6%), and the shortest stem (130 mm) in 6 patients (15.7%). Patients older than 80 years and those with a body mass index >30 had larger femoral defects ($p<0.05$).

Table. Proximal femur defect according to Paprosky's classification and relationship to stem length.

Paprosky Classification	Number of cases
I	18 (47.7%)
IIA	13 (34.2%)
IIB	7 (18.4%)
Femoral stem length	**Frequency**
130 mm	6 (15.7%)
150 mm	12 (31.6%)
170 mm	20 (52.6%)

The type of revision femoral stem was the same in all patients (Figure 3), but the acetabular fitting depended on the acetabular defect according to the Paprosky classification. In 35 patients (92.1%), a primary cup was used for an IIC or lower defect, while in 3 patients (7.9%) with IIIA defects, a revision cup was necessary. All acetabular components had dual mobility, and there were no significant differences in radiological outcomes, with correct integration based on Engh's criteria.

The assessment of heterotopic ossifications using the Brooker classification showed that 26 patients (68.8%) had no ossifications or type I ossifications, while 8 (21.1%) had type II, and only 3 (7.9%) had significant type III ossifications. A significant association was found between the presence of ossifications and VAS scores (p=0.01), but no correlation was observed with HHS scores.

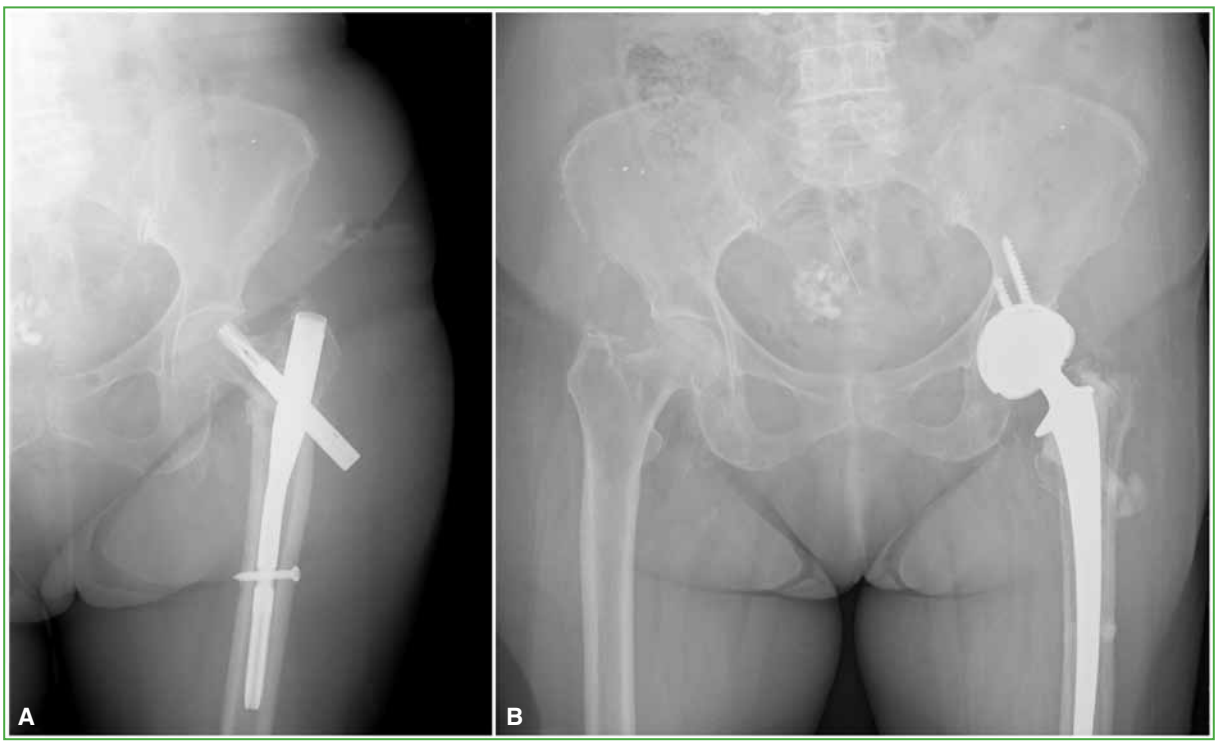

Figure 3. Anteroposterior radiographs of the pelvis. Revision surgery after failed osteosynthesis of a hip fracture. **A.** *Cut-out* one month after surgery with intramedullary nail. **B.** Revision femoral stem and dual-mobility cup after 10 months of follow-up.

Complications

During follow-up, 5 patients (13.2%) experienced complications. Two (5.2%) developed chronic infection of the revision prosthesis, requiring two-stage revision surgery, in which the same type of prosthesis was re-implanted in the second stage. Three cases of prosthetic dislocation (7.8%) were recorded: one required surgical revision, while the other two were managed with closed reduction and expectant management. There were no cases of component loosening or postoperative neurovascular injury.

Notably, no patients were lost to follow-up, and there were no reported deaths. The implant survival rate was 92.2%, with 7.8% of the sample requiring re-revision.

DISCUSSION

Hip fractures remain a global public health concern, frequently encountered in emergency departments[5-7,20] Despite continuous advancements in osteosynthesis materials, failure still occurs, often necessitating reoperation.[20] Femoral revision surgery with acetabular reconstruction is a preferred option in tertiary hospitals for patients with femoral bone stock defects and acetabular involvement, which pose both clinical and surgical challenges.[9,10]

Historically, various revision implants have been used for femoral reconstruction, with limited success.[21-23] Cemented stems have high loosening and migration rates due to issues at the bone-implant interface.[23] Similarly, uncemented porous and biologically coated stems have not demonstrated superior outcomes, with revision rates for aseptic loosening reaching 40% in some series.[24]

Following our center's approach to revision surgery, a combination of a dual-mobility cup and a cemented monoblock femoral stem was chosen for patients with minor proximal femoral defects (types I, II, IIIA). The femoral stem used has a physiological double curvature, smooth edges, and calcar support for uniform cement pressurization. Additionally, its beveled distal region with a reduced diameter minimizes traumatic insertion and intraoperative complications.

Patients with osteosynthesis failure often experience significant declines in quality of life. However, as demonstrated by the postoperative HHS scores in our study, mobility can be restored to a functional level following revision surgery, consistent with previously published findings.[25] Pain relief and improved function allow for a tolerable level of dependence, reducing caregiver burden and enhancing daily living activities.[5,6] The timing of revision surgery following osteosynthesis failure is critical, although it should ideally be performed when the patient is in optimal clinical condition.[5,6,25]

Our clinical and functional outcomes align with the existing literature. Li et al.[25] present a retrospective and descriptive study of 80 patients who underwent surgery after osteosynthesis failure, with a mean follow-up of 10 years and using the same therapeutic approach. The mean HHS was 75.1, with a homogeneous population comparable to that of the present study. When comparing the HHS of our patients with those who underwent other therapeutic options, we found no statistically significant differences. Diranzo-García et al. reported a mean HHS of 82.1 at the last clinical follow-up after evaluating the modular femoral stem option.[12]

In our series, osseointegration between the implant and the bone surface was complete, with no cases of loosening or increased radiolucency at the studied interface. It is true that the femoral defects included in this study were less severe than those reported in other series, where the rate of aseptic loosening reaches up to 20% in patients with a type IIIB femoral defect.[26,27]

Notably, in our study, severe femoral defects were associated with a higher complication rate, as three patients with a type IIB femoral defect required surgical reintervention ($p<0.001$).

The cumulative survival rate was 92.2% when considering surgical reintervention as a failure, with a minimum follow-up of 12 months in the studied sample. This survival rate and complication rate are comparable to those reported by other authors.[28]

Regarding complications, in the two cases requiring two-stage surgery for chronic infection, the HHS was lower than the mean at the last clinical follow-up due to the more aggressive surgical treatment and the greater number of interventions required in these patients. There was no difference in the outcomes of prosthesis dislocation between the case that required surgical revision and the two cases treated with closed reduction. This is likely due to the good clinical condition of the operated patients compared to the rest, which represents a limitation due to the heterogeneity of the population.

One limitation of our study is the absence of a control group to compare this treatment option with others for osteosynthesis failure. Additionally, the study population is highly heterogeneous, which may introduce biases into the clinical and functional outcomes. However, strengths of our study include the number of cases analyzed, the follow-up period, and the continuity in our center's research line, following several published articles on pelvic and hip pathology.

CONCLUSIONS

Patients with extracapsular hip fractures are subject to the well-known concept of "one-shot surgery." However, after failure, their quality of life and functional capacity should not be permanently compromised. In a second-stage approach, acetabular fitting with a dual-mobility cup and proximal femoral replacement using a cemented monoblock stem represents a viable option, offering acceptable clinical, radiological, and functional outcomes.

In appropriately selected patients, revision surgery may extend functional mobility and pain relief, contributing to a better quality of life in the final years.

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

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