ORIGINAL ARTICLE

Cementless total hip arthroplasty after acute femoral neck fracture in active patients. Prospective matched study with a minimum follow-up of 5 years

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Abstract

Objectives: To evaluate the outcomes of cementless total hip replacement after acute femoral neck fracture in active patients.

Material and methods: A prospective matched study was conducted to compare the results of 76 patients with fractures and 76 patients with osteoarthritis. The Harris score, short-WOMAC and SF-12 were used for the clinical assessment. The mean follow-up was 7.3 years (range 5–11).

Results: There were no significant differences in medical or surgical complications between the 2 groups. Functional outcomes were similar, but more walking aids were used in the fracture group. There were 6 revisions among the fracture group (one dislocation, 2 deep infections, 3 aseptic loosening), and 2 aseptic loosening among controls. There was no significant difference in arthroplasty survival at 10 years (88.7 vs. 96.1%, P = .15). The mortality rates at 2 and 10 years were similar.

Conclusion: Cementless total hip replacement for treatment of acute femoral neck fracture showed results similar to those of elective surgery for osteoarthritis in these selected patients.

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PALABRAS CLAVE
Fractura cervical femoral; Artroplastia total de cadera no cementada tras fractura cervical femoral aguda en pacientes activos. Estudio prospectivo emparejado con seguimiento mínimo de 5 años

Resumen

Objetivos: Evaluar los resultados de la arthroplastia total de cadera no cementada tras fractura cervical femoral aguda, en pacientes previamente activos.

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**Introducción**

La artroplastia hemiartrésica ha demostrado ser un tratamiento adecuado para la mayoría de las fracturas femorales no desplazadas.1 En general, la artroplastia total del hombro (THA) no se recomienda para los pacientes con esta fractura debido al riesgo de infección y los mayores costos.2 Sin embargo, la tasa de reintervención y la disminución de la movilidad de los pacientes están aumentando con el tiempo. El principal tratamiento recomendado sigue siendo la hemiartrésica, que ha demostrado ser más efectivo que la artroplastia total del hombro, lo que permite una recuperación más rápida y una mejor movilidad. Sin embargo, los tratamientos quirúrgicos para las fracturas femorales también presentan complicaciones, como la infección o la lesión del nervio isquiatico.3

La eficacia de la artroplastia total del hombro ha sido extensamente estudiada, incluyendo el uso de acetábulo no cementado en pacientes mayores.4 Esta experiencia ha sido extrapolada al tratamiento de fracturas de hombro; sin embargo, estas fracturas pueden presentar características inherentes a la lesión misma y a los pacientes con patología previa, como la artritis del hombro.5

**Materiales y métodos**

Empezamos en enero de 2001 con un estudio prospectivo comparativo de la artroplastia total del hombro en pacientes de promedio de 76 años menores de 76 años con coxartrosis. Para la valoración clínica se utilizó la escala de Harris, el WOMAC reducido y el SF-12. Seguimiento medio de 7,3 años (rango 5–11).

Resultados: No había diferencias significativas en las tasas de complicaciones médicas o quirúrgicas. Los resultados funcionales fueron similares, pero con mayor utilización de ayudas para caminar en los pacientes con fractura. Entre estos hubo 3 luxaciones, y ninguna en los controles. Entre los pacientes fracturados hubo 6 revisiones (una luxación, 2 infecciones profundas y 3 aflojamientos asépticos), mientras que en el grupo de coxartrosis hubo 2 aflojamientos asépticos. No había diferencia significativa en la supervivencia de la prótesis a 10 años (88,7 vs. 96,1%, p = 0,15). Las tasas de mortalidad a 2 y 10 años fueron inferiores.

Conclusión: La artroplastia total del hombro no cementada para tratamiento de fractura cervical femoral aguda se mostró similar a la cirugía electiva por artrosis en estos pacientes seleccionados.

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made of titanium alloy with a porous plasma-spray coating and pressure fitting after milling. They were secured with 2 divergent screws in all cases, regardless of bone quality. We also used high molecular weight polyethylene inserts in all hips. These inserts were sterilized with gamma radiation in air, and had an elevation of 12° and a metal head of 28 mm. All patients followed a standard postoperative protocol. We applied antibiotic prophylaxis for 24 h with first-generation cephalosporin, and thromboprophylaxis with low molecular weight heparin for 1 month. The patients received postoperative blood transfusions whenever hemoglobin levels fell below 8 g/dL. We did not use prophylaxis against heterotopic ossification. Load using a walking frame or crutches was authorized on the day after surgery if the pain allowed it.

Assessments

All patients with hip fractures were assessed by an internist and an anesthesiologist upon admission. Preoperatively, both the group of patients suffering fractures and those with coxarthrosis were assessed using the scale of activities of daily living by Katz et al. and the Mini-Mental test. According to the scale by Katz et al., all patients in both groups presented an A level of independence, as they did not require assistance for personal hygiene, dressing, sitting and rising from a chair or bed; and they had sphincter continence and were self-sufficient to feed. Cognitive function using the Mini-Mental test provided a score of 10 in all patients. The initial general health condition was assessed according to the number of comorbidities, taking into account that those which most affected the prognosis in hip fractures were arterial hypertension, heart disease, lung disease, kidney disease, stroke, diabetes, rheumatism and Parkinson’s disease. The pre-anesthetic risk was assessed according to the scale of the American Society of Anesthesiologists. We did not consider carrying out a clinical or preoperative functional assessment of the hip, as it was not possible to carry it out successfully in the group of patients suffering from fractures.

All patients in both the groups were assessed clinically and radiographically after surgery: at 6 weeks, 3 and 6 months, 1 year and then annually for at least 5 years. We used the Harris hip scale for clinical assessment. Anterior thigh pain was scored as absent, mild, moderate or severe, using the same criteria as in the pain subcategory of the Harris scale. Quality of life was also assessed, using the SF-12 questionnaire validated for Spanish for overall quality (physical and mental dimensions) and the reduced version WOMAC for the lower limbs (pain and function dimensions), both adjusted to a 0–100 scale (worst to best outcome).

We obtained standard, anteroposterior and lateral radiographs preoperatively and on each postoperative visit. The stability of the components was determined by comparing the radiographs at 6 weeks postoperatively with the last assessment conducted. For the acetabulum we applied the criteria of Gonzalez della Valle et al. for uncemented components, considering unstable those which presented continuous radioluencies of 1 mm or more, incomplete for at least 2 mm or migration of more than 2 mm or rotation greater than 2°. For the femoral component we applied the criteria of Engh et al. for uncemented stems, considering unstable those which presented continuous radioluency of at least 2 mm, progressive sinking greater than 5 mm or a change in position of at least 3°. We used the areas of Gruen et al. to locate radiolucent areas, and heterotopic ossification was graded according to Brooker et al.

Statistical analysis

The statistical analysis was performed using the software package SPSS® (SPSS Inc., Chicago, IL, USA), version 15.0. Values of $P \leq .05$ were considered significant. We used the Kolmogorov–Smirnov test to determine normal distribution. For comparisons between cohorts we conducted univariate analysis for categorical variables using the chi-square tests in variables with normal distribution, or the Mantel–Haenszel test for nonparametric data. For continuous variables we used the Student’s t test or the Mann–Whitney test. Relative risks (RR) were estimated with 95% confidence intervals (CI). We used logistic regression analysis to identify independent predictors of risk, calculating the hazard ratio with 95% CI. Kaplan–Meier analysis was used to calculate the cumulative survival and the log-rank test to compare survival curves.

Results

Between January 2001 and December 2007 we treated 455 patients suffering from acute displaced femoral neck fracture at our center, of which 90 met the inclusion criteria, of which we excluded 14 who were under the age of 60 years. Thus, the study group consisted of 76 patients treated with cementless THA. The group included 60 females and 16 males, with a mean age of 69.5 years (range: 62–86 years). The control group consisted of another 76 patients. The preoperative characteristics of both groups are shown in Table 1, with no significant differences between them. Moreover, considering the prosthesis model used, there were no significant differences regarding age ($P = .53$), gender ($P = .61$) and BMI ($P = .37$).

The mean postoperative follow-up period was 7.3 years (range: 5–11 years) in the fracture group and 7.1 years (range: 5–11 years) in the coxarthrosis group ($P = .62$). The mean delay of surgery in the fracture group was 3.2 days (range: 1–9 days). The mean hospital stay was 10.9 days (range: 5–12 days) in the fracture group and 7.2 days (range: 5–12 days) in the coxarthrosis group ($P = .001$). In both groups, all patients came from their homes and returned to them. The risk of perioperative blood transfusion was similar in both groups (RR 1.6; 95% CI 1.2–3.4; $P = .18$) in the fracture group (14 patients, 18.4%) and in the coxarthrosis group (9 patients, 11.8%).

Functional results

In the analysis of functional and radiographic results of THA, we excluded deaths of patients who had not undergone the minimum postoperative follow-up period of 5 years (6 fracture patients and 2 coxarthrosis patients). These cases did not include any THA complications in the last assessment conducted. Thus, the analysis of results included 70 patients with fractures and 74 with coxarthrosis.
There were no significant differences between groups regarding postoperative Harris score (Table 2) in the last follow-up, and in the case of surgical revisions and in the subsequent result. In the fracture group, 67 patients (95.7%) reported absent or mild pain in the hip and in 3 cases (4.3%) it was moderate or severe, whilst in the coxarthrosis group this was reported in 72 (97.3%) and 2 (2.7%) cases, respectively ($P = .47$). In the fracture group, thigh pain was not reported or was discontinuous in 69 patients (98.6%), and continuous or severe in 1 case (1.4%), whilst in the coxarthrosis group this was reported in 71 (96.0%) and 3 (4.0%) cases, respectively ($P = .62$). Regarding walking aids, in the fracture group there were 58 patients (82.8%) who did not use them or used a cane occasionally, 8 (11.4%) who used a cane permanently and 4 (5.8%) with 2 canes or a walking frame, whilst in the coxarthrosis group there were 71 patients (95.9%) who did not use a cane or did so occasionally and 3 (4.1%) who required a cane permanently. This difference regarding walking aids was significant ($P = .009$). The model of prosthesis employed did not influence the functional score, pain in the hip or thigh, or use of walking aids ($P > .31$). Subjective assessments, both regarding hip function with the WOMAC questionnaire and perceived quality of life with the SF-12 questionnaire, showed no significant differences between the groups (Table 2).

Radiographic results

The last evaluation did not include any significant differences between groups regarding the mean acetabular inclination angle ($P = .43$), which in the fracture group was $43.4^\circ$ (range: $31^\circ$–$55^\circ$) and in the coxarthrosis group was $44.7^\circ$ (range: $28^\circ$–$54^\circ$), or regarding the rate of varus femoral components ($P = .32$), which in the fracture group was 5 (7.1%) and in the coxarthrosis group was 3 (4.0%). There were no significant differences regarding the prosthetic model used ($P > .51$).

Regarding the condition of components, and in cases with revision, prior thereto, in the fracture group there were 66 acetabula (94.2%) with bone fixation and without radiolucency or osteolysis, another 2 with non-progressive radiolucency under 2 mm in areas 2 and 3 with stable fibrous fixation and without clinical significance, and another 2 with full radiolucency, which required revisions. At the femoral level, in the fracture group there were 66 stems (94.2%) with bone anchorage, 3 with non-progressive radiolucencies under 2 mm in zones 1 and 7 and without clinical significance, and 1 with progressive collapse, which required revision. In the coxarthrosis group, 71 acetabula (95.9%) had bone fixation with no radiolucency or osteolysis, 3 had non-progressive radiolucencies under 2 mm in zone 2, all without clinical significance and bone fixation, and 1 acetabulum had complete radiolucency which required revision. At the femoral level, there were 73 stems (98.6%) with bone fixation and 1 with progressive collapse, which required revision. In both the groups, the stem or acetabulum model employed did not influence the condition of the fixation of components ($P > .57$). There were 5 heterotopic ossifications in the fracture group and 4 in the coxarthrosis group, all of them grade 1 and without clinical significance.

Surgical revisions and complications

In the evaluation of results we considered valid those cases with a minimum follow-up of 5 years. Postoperative

<table>
<thead>
<tr>
<th>Table 1 Preoperative data.</th>
<th>Fracture</th>
<th>Coxarthrosis</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients. $N$</td>
<td>76</td>
<td>76</td>
<td>–</td>
</tr>
<tr>
<td>Age in years. Mean (SD)</td>
<td>69.5 (4.7)</td>
<td>69.8 (5.0)</td>
<td>842</td>
</tr>
<tr>
<td>Females. $N$ (%)</td>
<td>60 (78.9)</td>
<td>60 (78.9)</td>
<td>–</td>
</tr>
<tr>
<td>Body mass index. Mean (SD)</td>
<td>28.2 (0.8)</td>
<td>30.5 (4.3)</td>
<td>320</td>
</tr>
<tr>
<td>ASA (I−II/III−IV). $N$</td>
<td>58/18</td>
<td>62/14</td>
<td>275</td>
</tr>
<tr>
<td>Number of comorbidities. Mean (SD)</td>
<td>1.4 (0.5)</td>
<td>1.5 (0.8)</td>
<td>439</td>
</tr>
</tbody>
</table>

ASA, American Society of Anesthesiologists; SD, standard deviation.

<table>
<thead>
<tr>
<th>Table 2 Postoperative functional results.</th>
<th>Fracture</th>
<th>Coxarthrosis</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients. $N$</td>
<td>70</td>
<td>74</td>
<td>–</td>
</tr>
<tr>
<td>Follow-up in years. Mean (SD)</td>
<td>7.3 (2.4)</td>
<td>7.1 (2.3)</td>
<td>62</td>
</tr>
<tr>
<td>Harris scale. Mean (SD)</td>
<td>87.8 (13.7)</td>
<td>90.4 (7.7)</td>
<td>18</td>
</tr>
<tr>
<td>Hip pain. $N$ (%)</td>
<td>3 (4.3)</td>
<td>2 (2.7)</td>
<td>47</td>
</tr>
<tr>
<td>Thigh pain. $N$ (%)</td>
<td>1 (1.4)</td>
<td>3 (4.0)</td>
<td>62</td>
</tr>
<tr>
<td>Walking aid. $N$ (%)</td>
<td>12 (17.1)</td>
<td>3 (4.0)</td>
<td>.009</td>
</tr>
<tr>
<td>WOMAC pain. Mean (SD)</td>
<td>91.5 (12.9)</td>
<td>89.0 (13.9)</td>
<td>31</td>
</tr>
<tr>
<td>WOMAC function. Mean (SD)</td>
<td>83.8 (16.4)</td>
<td>87.1 (11.9)</td>
<td>22</td>
</tr>
<tr>
<td>SF-12 physical. Mean (SD)</td>
<td>79.7 (17.6)</td>
<td>84.2 (15.4)</td>
<td>10</td>
</tr>
<tr>
<td>SF-12 mental. Mean (SD)</td>
<td>82.4 (17.2)</td>
<td>87.6 (18.3)</td>
<td>08</td>
</tr>
</tbody>
</table>

SD, standard deviation; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.
complications are shown in Table 3. There were intraoperative fractures without displacement at the level of the calcar femorale in 2 hips (2.8%) in the fracture group, and in 1 hip (1.3%) in the coxarthrosis group (P = .47). All were treated by wired cerclage, without subsequent collapse of the stem and satisfactory functional outcomes. There were 4 infections (5.7%) in the fracture group. Of these, 2 were superficial and healed conservatively with satisfactory results, whilst the other 2 required surgical revision with replacement in 2 stages, with unsatisfactory results. In the coxarthrosis group, there were 2 superficial infections (2.6%), which healed conservatively with satisfactory results, with no cases of deep infection. The RR of infection did not differ between the groups (RR 2.1; 95%CI 0.3–12.3; P = .31). There were 3 dislocations (4.2%) in the fracture group, 2 of which appeared early and were resolved conservatively, whilst the other occurred at 2 months postoperatively and required replacement of the stem due to recurrence, all with satisfactory functional results. In the coxarthrosis group there were no dislocations.

As belated mechanical complications, 3 patients in the fracture group, mentioned previously in the radiographic assessment, required aseptic revision. Two were due to loosening of the acetabulum, with revision at 65 and 80 months postoperatively, and the other due to progressive collapse of the stem, without prior intraoperative fracture at 73 months postoperatively. In the coxarthrosis group there were 2 cases, mentioned previously in the radiographic assessment, of revision due to aseptic loosening, 1 of the acetabulum at 27 months postoperatively and another of the stem at 15 months postoperatively. The risk of aseptic loosening did not differ between the groups (RR 1.6; 95%CI 0.2–9.9; P = .47), and there were no significant differences between the 2 models of prosthesis employed (P = .86).

In summary, 6 hips (8.4%) required revision in the fracture group, of which 2 (2.8%) affected both components due to septic causes and 4 (5.7%) due to an aseptic component (2 acetabula, 1 stem loosening and 1 stem by dislocation). In the coxarthrosis group, 2 (2.7%) cases required revision due to aseptic loosening (1 acetabulum and 1 stem). Considering all causes of revision, there were no significant differences in risk between both the groups (RR 3.5; 95%CI 0.6–17.3; P = .12). According to the Kaplan–Meier method, survival at 10 years of the implant, considering revisions for any cause, was 88.7% (95% CI 80.9–98.3) in the fracture group and 96.1% (95%CI 90.7–100) in the coxarthrosis group, with this difference not being significant (P = .15). Excluding the cases of infection, survival of the acetabula for aseptic causes (Fig. 1) was 92.5% (95%CI 85.2–99.8) and 97.1% (95%CI 93.1–100), respectively (P = .18), whilst that of the stems (Fig. 2), was 93.3% (95%CI 86.6–100) and 95.7% (95%CI 91.1–100), respectively (P = .17).

Morbidity and mortality

Out of all the patients included in the study, 6 of them (7.8%) in the fracture group presented perioperative medical complications (2 hematemesis, 1 diabetic decompensation, 2 renal failures, and 1 pulmonary decompensation), compared to 2 patients (2.6%) in the coxarthrosis group (urinary tract infections). In both groups there were no cases of deep vein thrombosis. The risk of medical complications was not significantly different (RR 3.1; 95%CI 0.6–16.1; P = .137). The presence of these complications did not affect the final functional result, which was satisfactory in all cases.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Complications in total hip arthroplasty.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fracture</td>
</tr>
<tr>
<td>Intraoperative fracture</td>
<td>2 (2.8)</td>
</tr>
<tr>
<td>Superficial infection</td>
<td>2 (2.8)</td>
</tr>
<tr>
<td>Deep infection</td>
<td>2 (2.8)</td>
</tr>
<tr>
<td>Dislocation</td>
<td>3 (4.2)</td>
</tr>
<tr>
<td>Unstable acetabulum</td>
<td>2 (2.8)</td>
</tr>
<tr>
<td>Unstable stem</td>
<td>1 (1.4)</td>
</tr>
<tr>
<td>Total septic revisions</td>
<td>2 (2.8)</td>
</tr>
<tr>
<td>Total aseptic revisions</td>
<td>4 (5.6)</td>
</tr>
</tbody>
</table>

CI, confidence interval; RR, relative risk.
Data expressed in n (%).
Cementless total hip arthroplasty after acute femoral neck fracture in active patients

Coxarthrosis

There were no hospital deaths in either group. In the fracture group, 2 patients died in the first postoperative year (2 heart diseases), 2 in the second year (heart disease and tumor), 2 in the third year (stroke and tumor), and 2 in the period between 5 and 10 postoperative years (heart disease and respiratory failure). In the coxarthrosis group, 1 patient died in the first year (stroke), another in the second year (stroke) and another 3 died in the period between 5 and 10 postoperative years (stroke, heart disease and tumor). There was no significant difference in the cumulative risk of death in any of the annual periods until 5 postoperative years ($P = .10$), or between 5 and 10 postoperative years ($P = .32$). The logistic regression analysis identified as a risk factor for death the number of comorbidities (hazard ratio 2.7; 95%CI 1.0–7.4; $P = .045$), but not age, gender or the score on the American Society of Anesthesiologists scale ($P > .242$).

Discussion

The effectiveness of THA in degenerative hip disease has been clearly proven, as has the use of uncemented THA in elderly patients suffering osteoporosis. Likewise, THA has also shown its effectiveness in femoral neck fractures, although few studies have used uncemented THA in these fractures. Although hip fractures and coxarthrosis are different conditions, there are very few studies comparing the use of THA in these 2 scenarios. We have only found 4 such studies, 2 of them based on national arthroplasty registers and the other 2 comparing small samples with short follow-up periods. To the best of our knowledge, the present study is the largest prospective study and with the longest follow-up to date, although our series was composed of selected patients.

The main objective was to assess the results of THA after acute femoral neck fracture in active patients without dependencies, compared with those undergoing elective surgery for coxarthrosis. Our study found a satisfactory outcome in these selected patients. Functional outcomes were similar between the 2 groups, except for a greater use of walking aids in the group of patients with fractures. This was consistent with previous studies which provided function and quality of life assessments or compared clinical outcomes using the Harris pain scale.

Dislocation was cited as a major complication following THA for femoral neck fracture. In addition to risk factors common to all THAs, such as the approach route and femoral head size, the higher propensity for dislocation among fracture patients has been attributed to a relatively greater laxity of the perarticular tissues, a greater range of preoperative mobility and an increased risk of falling. A recent metaanalysis showed dislocation rates between 0% and 20% among fracture patients; double that among the elective surgery group, although the work was based on studies with different approaches, prosthesis models and surgeons. In our study there were 3 dislocations (4.2%) among patients with fractures and none in the coxarthrosis group, which we considered clinically relevant, since the lack of statistical significance observed could be due to the size of the groups studied. Other studies did not find differences in the rates of dislocation among patients with fractures from 3.5% to 7.5%, using the same approach as in our study and similar prostheses. Nevertheless, most of these dislocations did not require revision of components.

In our study, although there was a higher rate of revisions in the fracture group (8.5%) than in the coxarthrosis group (2.7%), the difference was not significant. However, this could be due to the sample size. The survival of the prostheses at 10 years, including septic and aseptic causes, was lower among fracture patients (88.7%) than among coxarthrosis patients (96.1%), but the difference was not significant, as also reported by other comparative studies. The use of cemented prostheses among fracture patients has also been associated with low revision rates of the components. By contrast, comparative studies based on arthroplasty registers reported a risk of revision among fracture patients which was 1.6 times higher than that among coxarthrosis patients, although this could be due to the high variability in the samples studied.

In our study, fracture patients had significantly longer hospital stays, possibly due to the preoperative time required for patient preparation and the greater number of perioperative complications. Although the 2 groups were similar regarding their scores on the American Society of Anesthesiologists scale and comorbidities, fracture patients presented a higher rate of medical complications. Nevertheless, these had no effect on mortality, perhaps due to the selection of our patients. The only risk factor for long-term mortality was the number of comorbidities. Another study noted that in addition to comorbidities, age was a risk factor for mortality following THA in fracture patients, although this series included non-selected patients with a greater mean age. Although mortality attributable to the fracture in the first 2 and 10 postoperative years was higher in the fracture group, it was not significantly different between both the groups (5.2% vs. 2.6% at 2 years and 10.5 vs. 6.5% at 10 years), and the causes of death were not related to the prosthesis. Other studies did not find a difference in
mortality between fracture patients and elective surgery patients either. Some reported a lower mortality among previously healthy fracture patients than our study, of 6% at 6 years.

The present study has the strength of its prospective design, but also significant weaknesses. One is the use of 2 prosthesis models, despite the fact that they were very similar in design, and no significant differences in the results were found. The other is the sizes of the groups studied, which, although greater than those published previously, means that the results should be interpreted with caution in relation to the significance observed or lack thereof.

Based on the available data, in our study the diagnosis of femoral neck fracture in previously active patients did not seem to influence the outcome of the THA procedure. We believe that uncemented THA is a satisfactory treatment for these selected patients, comparable to its use in elective surgery for primary osteoarthritis in terms of complications, revisions and survival of patients and prostheses. Further, well-designed and long-term studies would be required to contrast these results.

Level of evidence
Level of evidence II.

Ethical responsibilities
Protection of people and animals. The authors declare that this investigation did not require experiments on humans or animals.

Confidentiality of data. The authors declare that they have followed the protocols of their workplace in the publication of patient data and that all patients included in the study received sufficient information and gave their written informed consent to participate in the study.

Right to privacy and informed consent. The authors declare that this work does not reflect any patient data.

Conflict of interests
The authors have no conflict of interests to declare.

References