Does the Cementless, Hydroxyapatite on Porous, Long-stem Prosthesis Perform Well in Revision Total Hip Arthroplasty? A Multicenter Observation

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ABSTRACT
Objective: To determine the multicenter outcomes of the cementless, hydroxyapatite on the porous, long-stem prosthesis for revision total hip arthroplasty (THA) at multiple centres.
Study Design: Observational study.
Place and Duration of Study: Lanzhou University Second Hospital, Gansu Province People's Hospital, New City District of Jiuquan People's Hospital, from March 2014 to December 2019.
Methodology: The database in three centres was retrospectively reviewed hip arthroplasty during the study period. Patients who underwent revision THA using the cementless, hydroxyapatite on porous, long-stem femoral prostheses were included. Perioperative complications, functional outcomes including the Merle d'Aubigné-Postel hip questionnaire (MAP), Harris Hip Score (HHS), Oxford Hip Score (OHS), Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index, life independence, and patient satisfaction were analyzed, the radiographic evaluation was also performed.
Results: Fifty revision THA (50 hips) were included for analysis, the median interval between primary and index revision procedure was 5.1 (0.3-30) years, and the rate of perioperative complications was 18%. Patients were followed up for a mean of 3.1±1.5 (1.1-6.5) years. At the latest follow-up, the functional outcomes significantly increased compared to preoperative data (p<0.001). Thirty-nine patients (92.9%) were life-independent, and 36 patients (85.7%) were satisfied with the surgery. Subsidence was observed in 5 patients, osteolysis occurred in 3 patients, and no revision was required.
Conclusion: The cementless, hydroxyapatite on porous, long-stem prosthesis was a good choice for revision THA with a poor bone condition in the proximal femur, unstable PFF, and recurrent dislocations after THA, no severe complications were found.
Key Words: Arthroplasty, Hip, Reoperation, Hip prosthesis.

INTRODUCTION
The number of revision total hip arthroplasty (THA) has been rising yearly.¹² The management of extensive bone defects in the proximal femur or unstable periprosthetic femoral fracture (PFF) was used to be difficult because the traditional prosthesis did not meet the requirement of stability, to decrease the rate of dislocation.

The long-stem femoral prosthesis was first designed to maintain femoral stability and to reduce the pain in the thigh after revision hip arthroplasty.³⁴ It has been used in the revision THA in some studies.⁵,⁶ However, the best indications and whether the long-stem prostheses were effective for revision THA still needs to be explored. This study aimed to investigate the outcomes of the cementless, hydroxyapatite on the porous, long-stem femoral prosthesis in revision THA in multicentre observation.

METHODOLOGY
It was an observational study conducted at Lanzhou University Second Hospital, Gansu Province People's Hospital, New City District of Jiuquan People's Hospital. The databases of the hip arthroplasty from three centres between March 2014 and December 2019 were retrospectively reviewed. Patients who underwent revision THA using a cementless, hydroxyapatite on the porous, long-stem prosthesis, and with a minimum follow-
up of 1 year were included. The primary surgery was hemiarthroplasty (HA) or THA, and the indication for revision of a HA to THA was substantial arthritis or severe wear in the acetabulum. The indications for using the long-stem component were poor bone conditions in the proximal femur, unstable periprosthetic femoral fractures (PFF) (Vancouver type B or C), or recurrent dislocation with instability after primary THA. The exclusion criteria were bone tumors in the proximal femur or patients with poor general conditions. This retrospective research was approved by local ethics committees of each hospital, all patients were informed and they agreed to participate in the research. The data were collected in three centers by three local surgeons using the same criteria (JH, XY, and LZ), and the follow-up data were finally gathered and analysed by two authors (JH and XW).

After admission, the general conditions of patients were evaluated by the American Society of Anesthesiologists (ASA) scale, and the Charlson comorbidity index. Preoperative hip functional scores were evaluated by Merle d’Aubigné e-Postel hip questionnaire (MAP), Harris Hip Scores (HHS), Oxford hip scores (OHS), and Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index. The femoral bone defect was evaluated according to the Paprosky classification.

Patients underwent standard anteroposterior and lateral hip radiographs at the latest follow-up. The imaging was evaluated by two surgeons who were blinded to the research. The stability of the prosthesis was evaluated by criteria designed by Engh et al. The degree of the osteolytic lesions was graded and evaluated by 7 zones in the radiograph described by Gruen et al. The heterotopic ossification in the surgical site was classified as described by Brooker et al. Radiographic outcomes of PFF were evaluated by using the standard described by Beals and Tower et al.

The statistical analysis was performed by SPSS 24.0 (IBM, Corporation. Armonk, NY). Qualitative data were presented as numbers and percentages. Normally distributed quantitative data were presented as mean±standard deviation (SD). Non-normally distributed quantitative data were presented as the median and interquartile range (IQR), and comparisons between the non-normally distributed variables were tested by using the Wilcoxon sign test; p < .05 was considered to be significantly different.

RESULTS

Fifty consecutive patients (50 hips) met the selection criteria, including 28 males and 22 females, aged 64.2±12.1 (31-85) years. The BMI was 23.0±3.2 (15.6-30.5) Kg/m. The interval between primary and index procedures was 5.1 (0-30) years. The ASA scales were 2 (1-3), Charlson Comorbidity Index was 3 (0-5). The reasons for revision were chronic pain (30%), aseptic loosening (28%), PFFs (16%), periprosthetic joint infections (PJI) (10%), recurrent dislocations with instability (8%), trauma (6%), and femoral component fractures (2%). Thirty-eight patients used the 190 mm stem and 12 patients used the 260 mm stem. Thirty-eight patients (76%) needed blood reperfusion perioperatively.

The overall rate of perioperative complications was 18% (2 patients with intraoperative femoral fractures and 7 patients with postoperative complications, including superficial infection, dislocation, deep venous thrombosis, pneumonia, pressure sore, sciatic nerve palsy, and hemorrhagic shock). No severe complications were observed and no patients died of the postoperative complications during the follow-up.

Patients were followed up for a mean of 3.1±1.5 (range, 1.1-6.5) years. Six patients were lost to follow-up within 3 years after the surgery. Two died at the 2 and 4 years after index revision, respectively, none of them were died because of the index revision procedure. Finally, the functional outcomes and patient satisfaction were evaluated in 42 patients. The functional outcomes at the latest follow-up significantly improved when compared to preoperative data (p<.001, Table I).

At the latest follow-up, the gaits were normal or slightly limping in the majority of the patients (81%), with moderate limping in 6 patients. Thirty-nine patients (92.9%) were life-independent (Kartz A). The majority of the patients were satisfied with the surgery (85.7%), five patients were not sure about the satisfaction, 1 patient was unsatisfied.

At the latest follow-up, the radiographic results were available in 31 patients. According to Ength et al., the prosthesis was stable and excellent bone growth was observed in 26 patients (83.9%), 2 patients (6.5%) had subsidence of less than 5 mm in 2 years, 2 patients (6.5%) had subsidence of 6-10 mm in 5 years. One patient (3.2%) had subsidence of more than 20 mm in the third year after surgery (3.2%). Periprosthetic osteolysis occurred in 3 patients (9.7%), the results of PFF revision were excellent in 7 patients, good in 2 patients, and moderate in 1 patient. Neither trochanteric nonunion nor femoral nonunion was observed. The PJIs were controlled well and no reinfection was found during the follow-up (Figures 1-3).
Table I: Comparison of pain and functional outcomes between preoperative and the latest follow-up data.

<table>
<thead>
<tr>
<th></th>
<th>VAS in the hip</th>
<th>MAP</th>
<th>HHS</th>
<th>OHS</th>
<th>WOMAC</th>
</tr>
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<tbody>
<tr>
<td>Preoperative</td>
<td>6 (5-7)</td>
<td>10 (6-12)</td>
<td>63.5 (44-67.8)</td>
<td>35.5 (29-41)</td>
<td>142 (96.8-187.3)</td>
</tr>
<tr>
<td>Postoperative</td>
<td>1 (0-3)</td>
<td>15 (12-16)</td>
<td>83.5 (70.8-87.5)</td>
<td>18 (14-24)</td>
<td>50 (40.8-70.3)</td>
</tr>
<tr>
<td>p-value</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
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VAS: Visual analogue scale, MAP: Merle d’aubigné-postel hip questionnaire, HHS: Harris hip score, OHS: Oxford hip score, WOMAC: Western Ontario and McMaster Universities Osteoarthritis index. Values are expressed as interquartile range.

DISCUSSION

The main finding of the present study was that satisfactory functional outcomes and patient satisfaction were achieved by using a cementless, hydroxyapatite on the porous, long-stem femoral prosthesis in revision THA for poor bone conditions in the proximal femur, unstable PFF, and recurrent dislocations after primary THA, without severe complications.

The revision hip arthroplasty with the poor bone condition around the femoral component is challenging for surgeons. The long-stem prostheses have been demonstrated effective in revision hip arthroplasty with proximal bone deficiency. The design of HA on porous prosthesis was beneficial for early fixation and bone growth in the early stage, the groove design in the distal part can provide long-time rotational and axial stability. When compared with previous studies, this study showed that the long stem performed well in the revision total hip arthroplasty not only for the extensive bone defect in the proximal femur, unstable PFF but for those with recurrent dislocations.

The management of periprosthetic fractures and intraoperative femoral fractures was tough, especially in patients with...
severe osteoporosis. The supplementary fixation was necessary for maintaining the stability of the implants and bone grafts. The 260-mm long-stems were used for patients with Vancouver C PFF or patients with poor bone conditions near the distal femur that were caused by infections or unhealed shaft fractures, the PFFs were supplementally fixed by claw-shaped proximal femoral plates, standard femoral shaft plates, or cerclage wirings, no nonunion of the fractures were found at the latest follow-up.

It has been demonstrated that dual-mobility implants could prevent dislocations after revision surgery in patients with obesity.\(^{14}\)

Though the majority of the patients needed blood reperfusion perioperatively, no severe complications were observed. The intraoperative femoral fractures occurred in two patients with severe osteoporosis. Naik et al. found that long-stem prosthesis was related to hemodynamic instability and increased risk of mortality at one year.\(^{15}\) However, the blood loss during the revision procedure was moderate. Two patients died because of comorbidities that were not related to surgical complications, the complications were less severe compared with other studies.

Several limitations must be mentioned. This is a retrospective consecutive serious without comparative methods. The results in multiple centers may be unbalanced because of the preference of indications and different surgical techniques, and the unmatched demographic information. Furthermore, this is a short-term observation, long-term survival analysis still needs to be performed in the future.

**CONCLUSION**

The cementless, hydroxyapatite on porous, long-stem prosthesis was a good choice for revision THA with a poor bone condition in the proximal femur, unstable PFF, and recurrent dislocations after THA, no severe complications were found.

**FUNDINGS:**

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**ETHICAL APPROVAL:**

This study was approved by the ethics committee of the Lanzhou University Second Hospital (2020A-288), Lanzhou, Gansu, China.

**PATIENTS’ CONSENT:**

The study was designed retrospectively, all data were collected from clinical records and during the follow-up after ethical approval.

**COMPETING INTEREST:**

All authors declared no competing interest.

**AUTHORS’ CONTRIBUTION:**

JH, XW: Collected and analysed the radiographic data (study cohort and follow-up) and drafted the manuscript. BG: Analysed the radiographic data and modified the manuscript. XY, ZL: Performed the surgery. YX: Performed the surgery and censored the article. All authors approved the final version of the manuscript to be published.
REFERENCES


