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ORIGINAL ARTICLE

Evaluation of clinical outcomes of cementless total hip arthroplasty in patients under 30 years of age

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Abstract
Background Historically, performing a successful hip joint replacement in patients aged fewer than 30 years has been an orthopedic challenge. The newer generation of prostheses and surgical techniques has the potential to increase the longevity of implants. The purpose of this study was to evaluate the outcomes of cementless hip arthroplasty in patients aged fewer than 30 years.
Materials and methods In this cross-sectional study, 41 patients (46 hips) were studied with a mean age of 24, 4 (from 17 to 30 years) of whom underwent cementless metal–polyethylene hip arthroplasty from 2004 to 2007. The Harris hip score (HHS) was used to assess the functional consequences. Patients were followed up in terms of early complications (thrombophlebitis of the lower limbs, dislocation, hematoma and infection) and late complications (aseptic loosening, dislocation and reoperation) at weeks 3 and 6, at 3 and 6 months, 1 year after surgery and annually thereafter.
Results Patients were followed for an average of 5 years and 2 months (from 51 to 82 months). One early complication (symptomatic thrombophlebitis) and one late dislocation (2.2 %) were observed. There were no cases of aseptic loosening or osteolysis at the end of follow-up. The preoperative HHS was 59.6 (from 41 to 76), which rose to 82 and 83.5 after the 1-year and final follow-up, respectively, which was a significant increase.
Conclusions Hip arthroplasty using a new generation of cementless proximal porous prosthesis with resistant polyethylene to cover the joint surfaces in patients aged fewer than 30 years is satisfactory and is accompanied by low complications.

Keywords Total hip replacement · Hip arthroplasty · Cementless prosthesis · Hip osteoarthritis · Osteonecrosis

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Introduction

Several underlying diseases and conditions (such as osteonecrosis, secondary osteoarthritis and juvenile rheumatoid arthritis) cause hip disabilities and a significant reduction in the daily activities in young patients [1–4]. Treatment options for the end stages of arthritis include arthrodesis [5], resection arthroplasty [6], resurfacing arthroplasty [7] and either a cemented complete replacement of the hip [8] or a non-cemented hip replacement [4]. Arthrodesis is not acceptable to many patients, due to the loss of joint motion [1], and resection arthroplasty is less often considered because of its poor performance and unpredictable results in younger patients [1]. The previous generations of hip joint replacement prostheses were ineffective due to the

repeated pressures on the hip from high levels of physical activity in the young. Additionally, the weaker bone structure of the acetabulum in certain underlying conditions and a smaller femoral head size can increase the need for reoperation [1, 4].

In the previous studies, the failure rate of cemented arthroplasty surgery in short- to long-term follow-up has been reported to be 50 % (with the dominant aseptic loosening of cemented components) [9]. This potentially high failure rate has deterred surgeons from performing this operation. Joint replacement by a cementless prosthesis with advanced materials that cover the rubbing surfaces has led to the increased efficiency and longevity of prostheses and increased surgeons' acceptance of this technique [1–4]. It is also important to note that in most articles associated with hip arthroplasty in young people, the word "young" has different definitions and has been applied primarily to people under 40–50 years of age [8, 10–12], and reports related to this new method of joint replacement in patients younger than 30 years of age are rare [1–4, 13, 14]. For this reason, the treatment and functional results of this new prosthesis for this age group have remained unknown. This study was performed to assess the clinical, functional and radiographic findings of hip joint replacement by the cementless prosthesis in patients younger than 30 years of age (Figs. 1, 2, 3, 4, 5).

Materials and methods

This cross-sectional study was performed on 49 patients below the age of 30 years who underwent hip arthroplasty by the three main authors in Poursina, Fatemi and Bahonar hospitals in Rasht, Ardabil and Kerman, respectively, from 2004 to 2007. Eight patients were excluded from this study because of a lack of follow-up. The mean age of the 41 patients (46 hips) was 24.4 ± 3.5 (from 17 to 30 years). Twenty-four patients (58.5 %) were male, and 17 patients (41.5 %) were female. The left hip was involved in 22 cases (53.6 %), the right hip was involved in 14 cases (34.1 %), and both hips were involved in 5 cases (12.3 %). All surgery was performed with the postero-lateral approach. A porous-coated polyethylene metal cup was used for the acetabular component, and a proximal porous titanium alloy was used for the femoral component. A trabecular metal primary hip prosthesis (Zimmer Inc., Warsaw, IN, USA) or active stem (Evolutis, Briennon, France) was used for the femoral component, and a

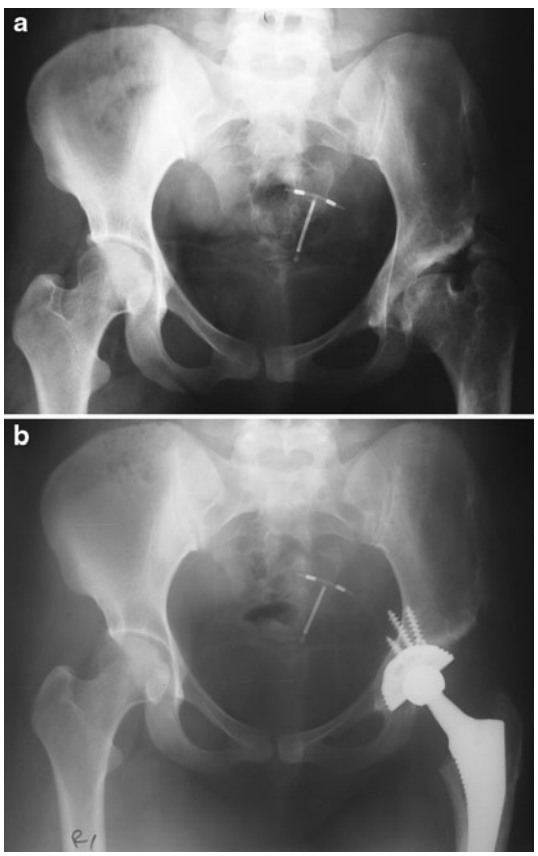

Fig. 1 A 35 year old female with a history of developmental dysplasia of hip with severe pain and limping

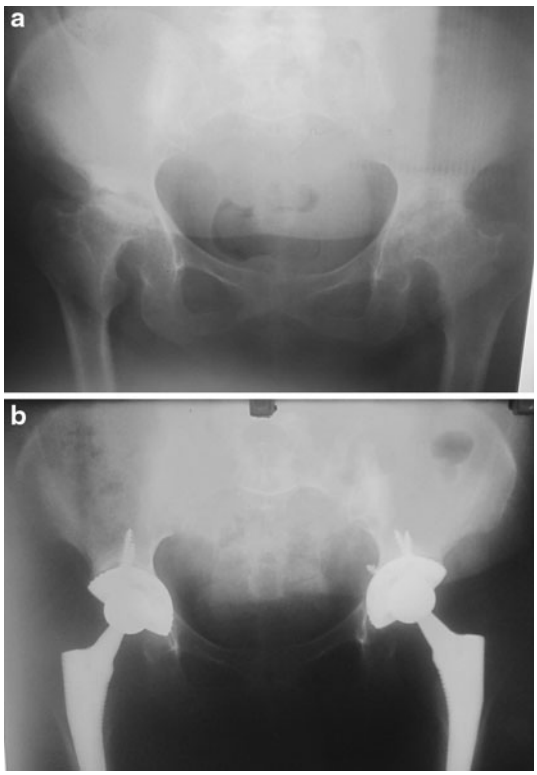

Fig. 2 A 54 year old female with bilateral avascular necrosis of femoral head

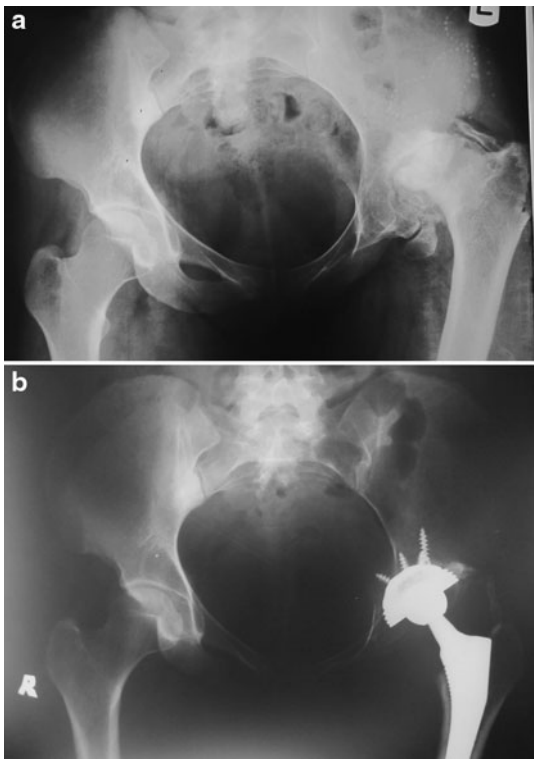

Fig. 3 A 24 year old female suffering from severe pain and limb leg discrepancy

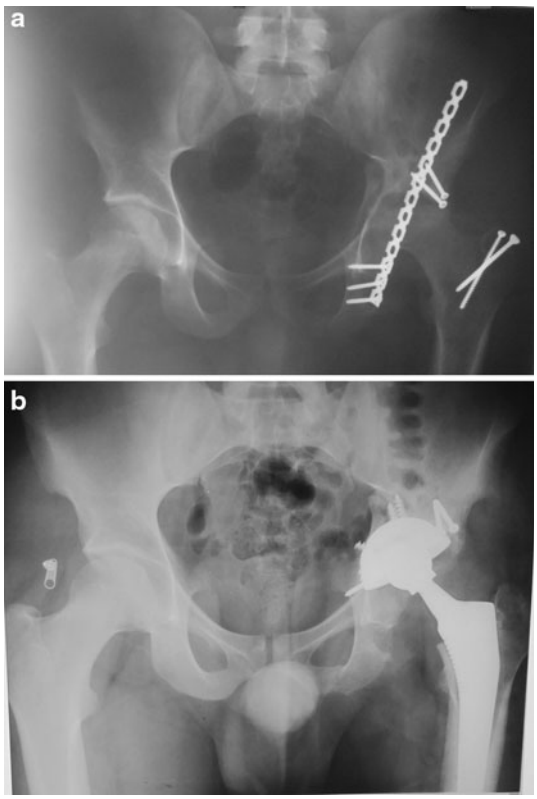

Fig. 4 A 23 year old male with a history of hip fracture dislocation

trabecular metal modular acetabular system (Zimmer Inc., Warsaw, IN, USA) or captive PRF cup (Evolutis, Briennon, France) was used for the acetabular component. An osteotomy of the femoral neck was performed in accordance with the required format pattern. The acetabulum was reamed to one millimeter less than the size of the metal shell of the cup or to where the subchondral bone could be observed. Next, the porous shell of the acetabular was placed on the bone graft material collected by reaming. The cup was placed at 20°–15° ante version and a 45° inclination. The position of the cup was re-assessed before removing the handle and was fixed by three screws; finally, the polyethylene on the articular surface of the shell was embedded. In the femoral side, after the preparation of the canal, the titanium stem was invested using a handle provided by the implant's manufacturer. The diameter of the head hip prosthesis was 22 mm in 14 cases (30 %), and 28 mm in the remaining 32 cases. The average operating time was 75 min (from 50 to 115 min). Post-surgery treatment protocol included the administration of a prophylactic antibiotic (first-generation cephalosporin) and thromboprophylaxis (low-molecular-weight heparin). Patients were encouraged to walk with the assistance of a cane or walker to help with weight-bearing 24 h post-operation and to walk completely unassisted after 6 weeks.

All patients were evaluated for early complications (including lower limb thrombophlebitis, symptomatic pulmonary embolism, early dislocation, hematoma and surgical site infection) and late complications (including aseptic loosening, dislocation, osteolysis and revision) at 3 and 6 weeks postoperation and at 3, 6 and 12 months after surgery and then annually. A radiographic anterior–posterior and lateral series was taken for the assessment of the prosthesis status, loosening, osteolysis and wear. A confirmed loosening was considered to be one of the following signs: a lucent line in each of the radiographs, the femoral subsidence more than 2 mm or the acetabular component was tilted [15]. Either the cortical or trabecular loss of bone mass was also considered to be evidence of osteolysis [16]. The Harris hip score was used to assess the functional consequences at the preoperative visit, 1 year postoperatively and at final follow-up [17]. This score includes four main sections (pain, patient function during various activities, deformity rate and range of motion of the hip).

The scores were rated as 90–100, excellent; 80–89, good; 70–79, moderate; and less than 70, poor. Patients were recalled and all of the above variables were re-evaluated. The data analysis was performed using SPSS software version 19. Repeated measure analysis with a significance level of 0.05 was used for the comparison of quantitative variables.

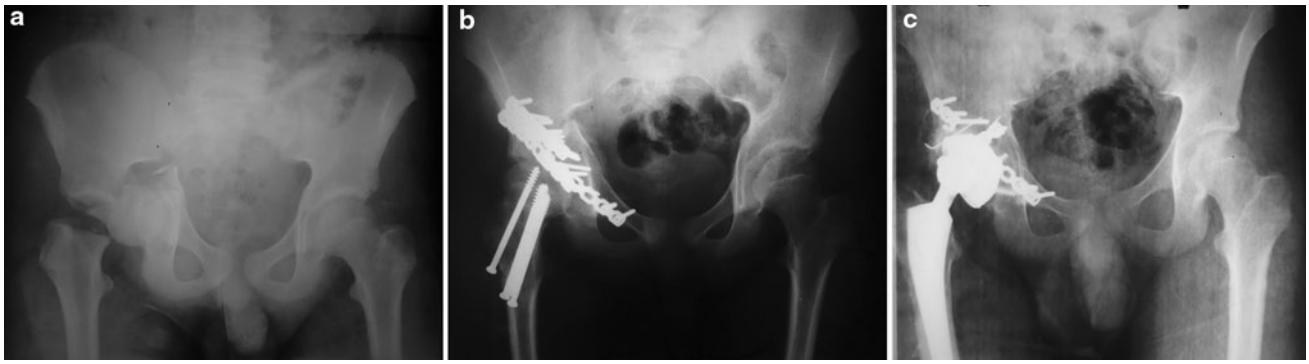

Fig. 5 A 17 year old patient with simultaneous femoral neck and acetabulum fracture resulting in avascular necrosis of femoral head

Results

The mean follow-up time of patients was 5 years and 2 months (62 ± 8 months, from 51 to 82 months). The underlying diseases included hip osteoarthritis secondary to Legg-Calve-Perthes Disease in 15 hips (32.6 %), hip osteoarthritis secondary to a congenital dislocation in 14 hips (30.4 %), osteoarthritis due to avascular necrosis diseases in 9 hips (19.6 %), post-traumatic arthritis of the hip in 5 hips (10.9 %) and other causes in 3 cases (6.5 %) (Figs. 1–5). Among early complications, one case (2.2 %) with symptomatic thrombophlebitis was found to have a full recovery after anti-thrombolytic treatment. One case (2.2 %) with a late dislocation was also observed following a road-accident trauma 3 years after surgery. A closed reduction was performed for him with no complications. Evaluation images showed that all stems were placed correctly, and no radiological signs of loosening or femoral subsidence were observed. No cases of aseptic loosening or osteolysis were observed at the end of the follow-up period. The Harris hip score was 59.6 ± 9 (from 41 to 76) before surgery and rose to 82 ± 7 (from 71 to 93) 1 year post-surgery and to 83.5 ± 7.3 (from 71 to 97) at the final follow-up ($\rho < 0.0001$). The Harris hip score showed that before treatment 37 cases (77 %) had a poor grade, and 11 cases (23 %) had a moderate score. After 1 year of follow-up, 14 patients (29.2 %) were ranked as moderate, 23 patients (47.9 %) had a good score, and 11 patients (22.9 %) had an excellent score. At the final follow-up, 9 patients (18.8 %) had a moderate rating, 26 patients (54.2 %) had a good rating, and 13 patients (27 %) had an excellent rating. There were no cases ranked as poor in the final follow-up.

Discussion

The hip arthroplasty technique has shown itself to be a reliable and durable method of choice in elderly patients in long-term follow-up [18]. However, studies performed on younger patients with this older technique have had a high failure rate (up to 51 % of cases) [2, 9, 19, 20]. In Wangen's research, the treatments—functional results of non-cement hip arthroplasty using the old-generation hydroxyapatite in 49 hips (44 patients less than 30 years)—were followed up for 10–16 years. These researchers have performed revisions in 24 hips because of the mechanical failure of the acetabular component. However, the results using stems were excellent [2]. More daily activities in the young in comparison with elderly patients, underlying diseases and the use of the first-generation cement and polyethylene stems are considered to be the primary causes of failure [9, 19, 20]. Advances in surgical techniques and modern implant designs, including the use of proximally coated stems, tapered cementless stems and the use of a new generation of articular surface covering materials (cross-linked polyethylene) and intraoperative care, have increased the longevity of the newer prostheses [21]. This study suggests a high recovery (97 % survival rate) with the cementless prosthesis proximally porous-coated metal–polymethylene technique in the short- to medium-term follow-up (mean follow-up period of 5 years). In the few studies of a similar type in which the new generation of implants for hip arthroplasty has been used in younger patients, the survival rate of prostheses in the medium-term follow-up was between 90 and 96 % [22, 23]. These findings are promising, but long-term follow-up to assess the longevity of these prostheses in younger patients seems necessary.

Because few papers specifically assessed the treatment—functional outcomes of the modern techniques of hip arthroplasty in patients younger than 30 years of age—and other articles have rarely classified treatment findings according to age subgroups, determining the precise functional success rate in this age group is difficult. There was no complication or revision in Restrepo's study and in a co-study with a 6.6-year follow-up, there was only one revision following severe wear at the 10-year follow-up.

These authors concluded that the cementless hip arthroplasty significantly improves performance and reduces pain in very young patients [1]. In 2010, Clohisy and colleagues followed 88 patients (aged <25 years) with new hip joint replacement prosthesis for a mean duration of 4.2 years. Major complications were observed in 9 cases, and 7 cases underwent revisions of the hip. This study revealed that the new hip joint replacement improved performance [3]. Only one case with a delayed dislocation was observed at the end of our study, and a closed reduction was performed for the patient, who achieved a full recovery. No case required a revision.

Different tools are used to examine the functional outcomes of hip joint replacement, techniques of which the Harris hip score is the most common. The final Harris hip scores in Restrepo's study on 35 hips (aged fewer than 20 years), Clohisy's study on 102 hips (aged fewer than 25 years), Dudkiewicz's research on 11 hips (aged fewer than 30 years), Bessette's review of 15 hips (aged fewer than 21 years), Costa's study with 53 hips (aged fewer than 30 years) were 77.3 (range 60–99), 83 (range 26–100), 90.6 (range 34–97) and 93 (range 47–100), respectively [1, 3, 4, 13, 14]. In our study, the final Harris hip score was 83.5 (range 71–97), which was consistent with the above-mentioned studies.

One of the main concerns following hip arthroplasty is the articular surfaces polyethylene wear that causes osteolysis and aseptic loosening. Worn patches activate macrophages and osteoclasts that cause osteolysis and loosening [2]. The previous studies have shown that this problem is more serious in younger patients. Kobayashi and colleagues, in a 14-year follow-up, found that the prevalence of radiographic loosening of the acetabular section was almost doubly frequent in young patients in comparison with the elderly (29.1 vs. 14.3 %) [24].

One of the limitations of this project is the short-term follow-up, and therefore, the rate of loosening or osteolysis is uncertain. Patients with multiple diagnoses (different etiopathogenesis) were another limitation of this study that consequently may undermine the therapeutic outcomes, especially the long-term functional results. Finally, the daily physical activity of patients during follow-up was not collectable, and therefore, the analysis of this risk factor (which can alter the failure rate) was not performed. The strengths of this study were its acceptable sample size and multi-center sampling. Additionally, the usage of the new generation of prosthesis hip arthroplasty in patients younger than 30 years of age was another advantage of this study that should be considered.

Conclusions

It appears that hip arthroplasty using the new generation of proximal porous and resistant polyethylene covering for the joint surfaces of cementless prostheses can lead to improve therapeutic and functional outcomes for patients, reduce complications and improve the survival and stability of the implants in patients younger than 30 years of age.

Conflict of interest None declared.

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