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Original article

The experience of an indipendent center with the MINIHIP® femoral stem

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Abstract: The implantation of short femoral stems has significantly increased over the past decade, thanks to their preservation of bone stock, allowing for easier potential revision of components and physiological joint reconstruction. Their main features are metaphyseal fixation and partial retention of the femoral neck which lead to biomechanical advantages and high stability. They also guarantee the preservation of bone stock and insertion through minimally invasive approaches. Fifty-one non-consecutive patients with osteoarthritis or avascular necrosis were treated by two senior surgeons with total hip arthroplasty (THA) with anterior or anterolateral approach between April 2013 and October 2016. Cementless short femoral stem monobloc (Minihip, Corin, Cirencester, UK) was implanted in all patients who were studied retrospectively. Radiographic outcome was analyzed and clinical outcomes were assessed with Harris Hip Score (HHS), Hip handicap and Osteaorthritis Outcome Score (HOOS) and Oxford Hip Score (OHS). Based on radiological results we did not find periprosthetic osteolysis while bone resorption was evaluated in 5 implants which were classified according to Gruen. The MiniHip stem demonstrates adequate metaphyseal grip, excellent implant stability to ensure implant survival. (www.actabiomedica.it)

Keywords: short stems, metaphyseal fixation, primary hip arthroplasty

Introduction

Cementless short femoral stems in hip arthroplasty, defined by some authors as 120 mm or less in length, were introduced in the mid '90s to treat young patients affected by degenerative diseases and that usually have long life expectancy and high functional expectations (1,2,3). Their main characteristics are metaphyseal fixation and partial retention of the femoral neck that lead to biomechanical advantages and high stability. Moreover they guarantee preservation of bone stock and insertion through minimally invasive approaches (4,5).

Several studies have confirmed that the length of these stems does not influence the implant stability in long term follow ups provided that a primary stability is reached, leading to subsequent efficient osseointegration (6). Primary stability depends on multiple factors such as implant size and design, bone quality, type and extent of coating, patient weight and the press fit obtained (7) . Furthermore they simulate physiological load transfer, promoting complete proximal femur transmission and natural stress distribution in order to avoid bone resorption and implant loosening (8). Physiological load transfer along the diaphysis and the greater trochanter seems to be due to the preservation of the neck and the trabecular systems of the metaphyseal cancellous bone which permits an increased bone ingrowth, probably due to the intact blood supply (2,9). Bone sparing is fundamental to preserve bone stock for possible future revision surgery, mainly in young patients.

Short stems have a high degree of freedom of positioning in femoral metaphysis so surgeons should

consider and calculate implant varus-valgus, height and ante-retroversion. Thus femoral offset usually can be reproduced (10)

A recent study reported that short stem could be implanted in the elderly as long as markedly reduced bone quality with femur morphology of Dorr type C is excluded during preoperative evaluation (11,12).

Minihip (Corin, Cirencester, UK) is a monoblock cementless short stem designed to adapt to the femoral medial calcar in order to preserve the great trochanter and so to conserve bone, retain the femoral neck and leave the femoral diaphysis intact. It is made of a titanium alloy with a hydroxyapatite coating in the proximal area.

Materials and Methods

Between April 2013 and October 2016, 51 non consecutive patients suffering from osteoarthritis or avascular necrosis were treated by two senior surgeons with total hip artrhoplasty (THA) with anterior or anterolateral approach. Monoblock cementless short femoral stem (Minihip, Corin, Cirencester, UK) was implanted in all patients that were retrospectively studied. Informed consent was obtained from all of them.

The Minihip stem has an anatomic shape mimicking the natural curvature of the medial calcar. It highly conserves bone, retains femoral neck, and leaves the diaphysis intact. The coating of the stem represents 80% of its surface.

Patients affected by osteopenia, an oncologic pathology and BMI>35 were excluded.

The mean age was 64,18±10.98 years (range 22–79). Three patients suffered from bilateral osteoarthritis and received surgery in a two-stage procedure for a total 54 implants. During the subsequent follow-up, 8 patients were excluded from the study: two died for reasons unrelated to the THA, one reported acetabular revision surgery in another hospital and refused to share documentation, two refused the follow up due to the recent SARS COV 2 pandemic, three were untraceable. The statistical analysis was made on 45 THA in 43 patients with a mean age of 63,6±10.68 years (range 22–79).

Harris Hip Score (HHS), Hip disability and Osteaorthritis Outcome Score (HOOS) and Oxford Hip Score (OHS) were used for the clinical assessment (13) . HHS was evaluated prior and after surgery, while HOOS and OHS were recorded only at the time of final follow-up. Preoperative planning of the implants was performed on digital radiographs using TraumaCad (Brainlab AG Munich Germany). An anteroposterior and lateral digital radiograph study were taken for each patient preoperatively, postoperatively before discharge and at final follow-up. Radiolucency, hyper or hypotrophy, subsidence, pedestal formation were noted to verify bone remodeling process around the stem in Gruen zones that were adapted to the short stem: zones 1-2 and 6-7 in the coated upper two-thirds of the stem medially and laterally respectively, zones 3-4 in the uncoated distal stem region and zone 5 at the stem tip. Heterotopic ossification were detected according to Brooker classification (14).

Data were collected by three fellows supported by a senior surgeon, the latter involved in performing the procedures. Data were analyzed using STATA software, version 13 (StataCorp, College Station, TX). Continuous variables are presented through mean and standard deviation (SD); normality of distribution was evaluated by the Shapiro-Wilk test. Group comparisons were performed through paired t-test. An α-level of 0.05 was assumed as guide for significance.

All participants provided written informed consent to participate in this study. This study was con-ducted under the principles of the Declaration of Helsinki.

Results

The mean follow up was 69,6±8.97 months (range 57-89).

There was a statistically significant reduction in HHS from a pre-treatment value of 43,45±5.25 (range 32-55) to a value at follow-up of 92.26±7.15 (range 57-100) with a $p<0.01$ (Fig 1).

At follow up the mean OHS and HOOS were 45,6±2,28 (range 38-48) and 91.9±5,67 (68-100) respectively.

Unfortunately cases were insufficient in number to allow a significant statistical study between groups selectedon sex, age, implant dimension, pathology.

We did not deal with intraoperatory and periprosthetic femoral fractures at follow-up. Furthermore there was no femoral component aseptic loosening

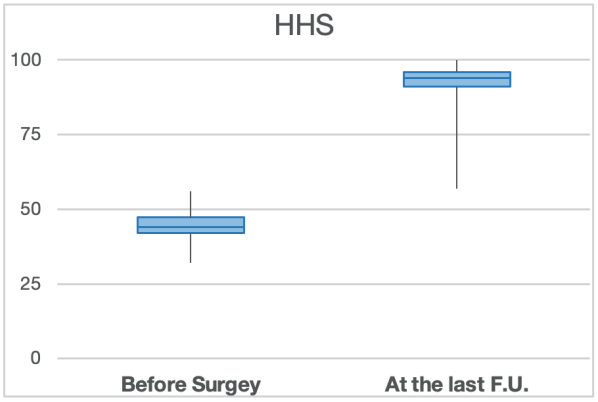

Figure 1. Values of HHS Score

while a patient underwent acetabular revision surgery for symptomatic aseptic mobilization (Fig 2).

According to radiological results we did not find periprosthetic osteolysis while bone resorption was assessed in 5 implant and was classified according to Gruen. There were four in Gruen zone 1 and one in Gruen zone 2 and 7 respectively. One stem presented two resorption areas in Gruen zones 1 and 7. (Fig 3) In all cases patients did not refer pain.

Heterotopic ossifications (HO) were assessed with the Brooker classification. We detected eight HO total cases: five were classified as grade I, two as grade II and one as grade IV. The latter had severe ROM limitations while the others had none.

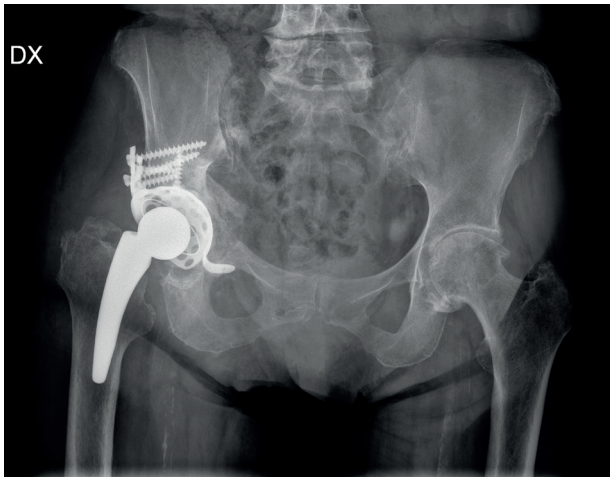

Figure 2. X- Ray after acetabular revision surgery (Pelvis AP view)

Discussion

Implantation of short femoral stems has notably increased over the last decade, due to their bone stock preservation, allowing easier potential component revision, and physiological joint reconstruction. Minihip cementless femoral stem was developed in order to preserve the femoral neck and to provide fixation and primary stability. According to our results, this stem reached optimal function and restoration of hip range of motion.

There are many literature data on short and medium-term short stems but few long-term data are reported. Van Oldenrijk et al (15) in a review work indicated that most of the authors reported a follow-up of less than 5 years.

Some specific works on the MiniHip stem have reported an overall survival of 98.16%, 97.26% and 99.3% after 60, 18 and 37 months, respectively, which are very interesting data.

Dettmer et al (16) reported good HOOS results at one year follow ups in a study where they compared short stem with resurfacing arthroplasty, but total HOOS was not evaluated so it is difficult to compare the studies. Moreover there was a slight difference in short stem indications based on patient's age despite the fact while although we prefer to consider bone quality. Teoh and colleagues (17) reviewed a huge cohort of patients at 5 years follow up. Their and our results are similar and include HHS, HOOS and failure rate. They had three cases of major stem subsidence, probably due to under sizing, and two of them required revision at 3 months from first implant. In 2018 Von Engelhardt published a long term follow up study that confirmed our good functional and clinical outcomes measured with HHS and HOOS. Moreover the overall survivor rate at nine to ten years was 97.31% (18).

In this study we had an average follow-up of 69.6 months with no case of subsidence but with the radiographic finding of areas of radiolucency in 5 plants: in zone 1 of Gruen, four cases, and in zone 2 and 7 of Gruen in 1 case. One case presented asymptomatic areas of osteolysis in zone 2 and 7.

We did not need to revise the femoral component in any of the cases with an overall survival rate

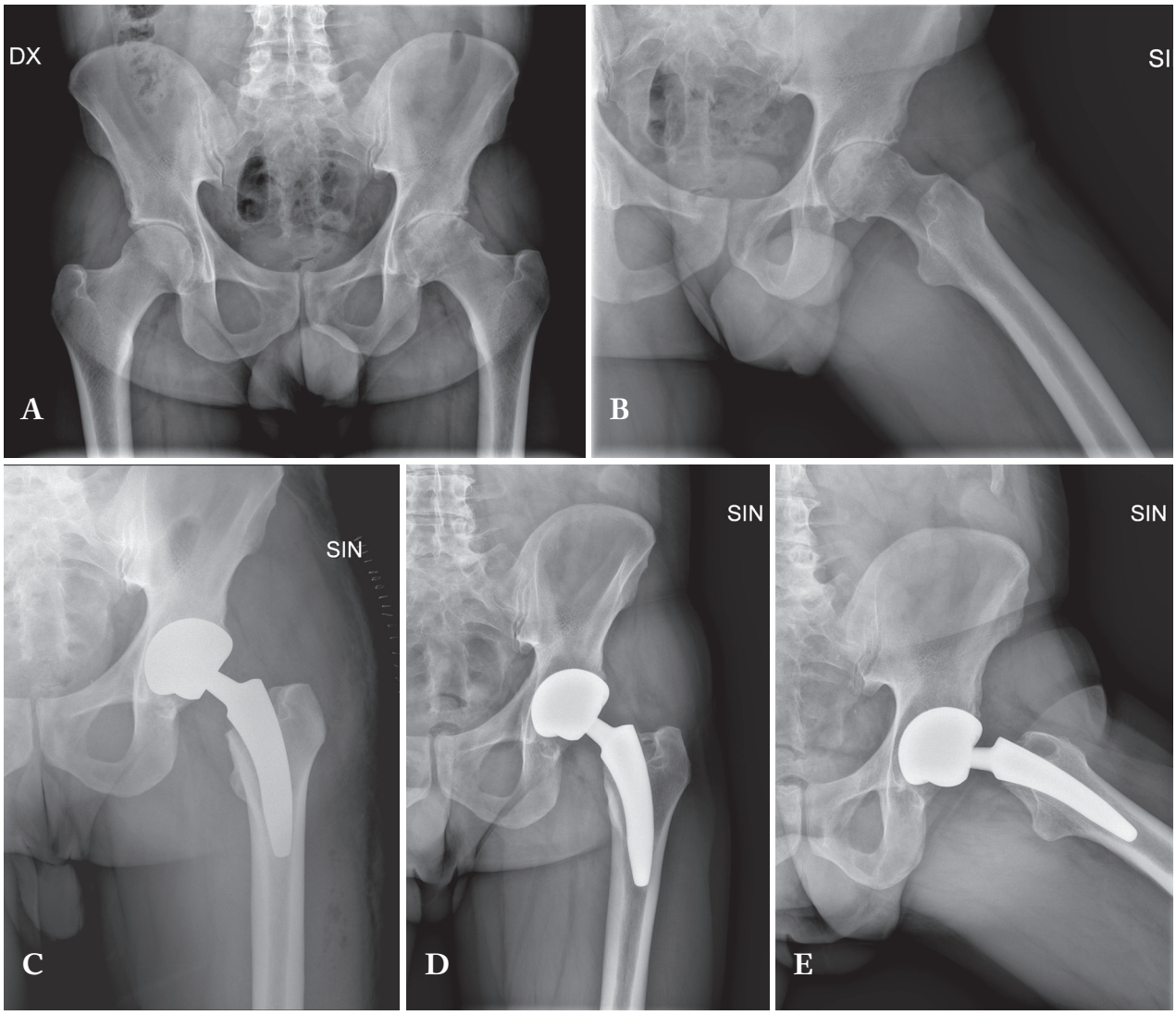

Figure 3. A) Preoperative X- Ray (Pelvis AP view); B) Preoperative X- Ray (Hip lateral view); C) PostOperative X-Ray; D) 6 years follow-up X-Ray (Hip AP view); E) 6 years follow-up X-Ray (Hip Axial view)

of 100%. 0.45% of the implants underwent acetabular revision for aseptic cup loosening.

In the present study we found 8 cases of Heterotopic Ossification classified according to Brooker in five degrees I, 2 degrees II, 1 degree IV, despite pharmacological prophylaxis being put in place in all cases with Indomethacin (19-20). The case with grade IV heterotopic ossifications according to Brooker was subjected to their removal without revision of the prosthetic components.

In our results the implant worked correctly and this is confirmed by the statistically significant improvement in the HHS, OHS and HOOS scores.

Initial bone resorption in the periprosthetic areas of the femoral stems is often described in the literature.

This is also confirmed by the specific studies for the MiniHip stem. If these areas are monitored over time, it is evident that with the MiniHip stem there are earlier remodeling phases in the proximal regions compared to conventional stems (21-24).

The MiniHip stem therefore seems to confirm the theory that the short stem may represent a more physiological transfer system of the proximal load (25). To this we must add that in the literature there are data

of a lower frequency of thigh pain compared to traditional stems.

The success of short stems and their advantages have led more and more surgeons to use them in young patients in order to save bone and ensure physiological load transfer. In this work, however, good-excellent results were also obtained in elderly patients up to 79 years of age.

The major concerns related to the use of short stems in the elderly are the increased risk of intraoperative periprosthetic fractures and the risk of subsidence in the postoperative period. Both of these complications are more often due to technical errors caused by the particular greater accuracy required to ensure the stability of the implant with these stems.
Therefore, from the analysis of our data, it can be stated that the MiniHip stem could be a reliable alternative in a large cohort of patients, from the active young to the elderly.

Conclusions

The use of the short stems including MiniHip, when correct planning is carried out, allows to restore the physiological distribution of the loads allowing both the compressive and traction forces to pass through the reconstructed joint in a more similar way to the native hip compared to replacement prosthetic with traditional stem. Furthermore, the absence of contact between the stem and the distal cortex can reduce stress shielding, bone resorption and thigh pain, possible causes of failure or poor subjective satisfaction of the patient.

This study revealed an excellent performance of the MiniHip stem which demonstrates adequate metaphyseal grip, excellent implant stability to ensure implant survival.

However, studies with larger numbers of patients and longer follow-up are needed to confirm the data from this study

Conflicts of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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