

ARE PROXIMALLY COATED BETTER THAN FULLY COATED CEMENTLESS STEMS FOR TOTAL HIP REPLACEMENT? A DXA STUDY

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Abstract

The aim of this study was to compare femoral bone remodeling after total hip replacement with two different cementless stems, a proximally coated and a fully coated one.

We performed dual energy X-ray absorptiometry in 27 patients with total hip arthroplasties with one of the two mentioned stems 1 year after operation and compared the results.

For both stems there was a decrease in bone mineral density but with some differences. The femur with the proximally coated stem had the greatest mineral density decrease in Gruen regions 1 and 7 this being greater than the decrease of density around the fully coated stem. Overall bone loss was greater for the proximally coated stem than the fully coated one.

These results are underlying the importance of the stem design in bone remodeling after total hip replacement.

Keywords: cementless total hip replacement, bone mineral density, DXA.

SUNT STEMURILE NECIMENTATE PROXIMAL ACOPERITE POROS MAI BUNE DECÂT CELE ACOPERITE ÎN ÎNTREGIME PENTRU ARTROPLASTIA TOTALĂ DE ȘOLD? UN STUDIU DEXA

Rezumat

Scopul acestui studiu a fost de a compara remodelarea osoasă femurală după artroplastia totală de șold cu două stemuri necimentate diferite, unul cu acoperire proximală și unul cu acoperire pe toată suprafața.

Am efectuat osteodensitometrie DEXA la 27 pacienți cu artroplastie totală de șold cu unul din cele două stemuri menționate la 1 an de la intervenția chirurgicală și am comparat rezultatele.

Pentru ambele tipuri de componente a avut loc o scădere a densității minerale osoase, dar cu unele diferențe. Femurul cu stem cu porozitate proximală a prezentat cea mai importantă scădere a densității minerale la nivelul zonelor Gruen 1 și 7, aceasta fiind mai mare decât scăderea densității de la nivelul femurului cu stem în întregime poros. Per global, pierderea osoasă a fost mai mare în cazul stemului proximal poros, comparativ cu cel în întregime poros.

Aceste rezultate subliniază importanța designului componentei femurale în remodelarea osoasă după artroplastia totală necimentată de șold.

Cuvinte cheie: artroplastie totală necimentată de șold, densitate minerală osoasă, DEXA.

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Introduction

Cementless fixation is considered by many surgeons to be the gold standard for hip replacement especially in active patients, with reliable long term results. This “biological” fixation is achieved in two stages: primary, press-fit fixation and secondary with osseointegration. The latter process represents the host bone response to the implant and is achieved by bone ingrowth. However, proximal femoral bone resorption due to distal stress transfer (i.e. stress shielding) seems to occur to a substantial degree [1]. The greatest bone loss has been found during the first 3–6 months after surgery in the proximal part of the femur [2]. Many factors may affect bone remodeling after total hip arthroplasty (THA). The stem design is thought to be one of the most important ones [3]. For a decade, advances in the understanding of bone remodeling around hip arthroplasties have concentrated on the femoral components [4]. There are two main categories of cementless stems on the market: proximally porous-coated tapered stems that achieve primarily proximal fixation and fully coated stems that achieve both proximal and distal fixation. In the recent years there has been a trend towards the use of proximally coated stems for its proposed advantages: less extensive stress shielding with less bone loss and better survivorship of the implant. Dual energy X-ray absorptiometry (DXA) is the method of choice to accurately determine the bone mineral density (BMD, g/cm^2) around cementless implants [2,5,6].

We have analyzed prospectively the BMD changes around two different types of uncemented femoral stem using DXA analysis.

Patients and Methods

We assessed 27 patients operated in our clinic with cementless THA. Of these, 17 had a proximally coated fiber metal tapered (FMT) femoral component (Zimmer, Warsaw, USA) (group A) and 10 had a fully coated Metabloc (Zimmer, Winterthur, Switzerland) stem (group B). In group A there were 9 men and 8 women with a mean age of 57.9 years and in group B there were 7 men and 3 women with a mean age of 57 years. The acetabular components were the same for each patient. We used Trilogy (Zimmer) acetabular cups and standard polyethylene liners. All heads were 28 mm, metallic. The Fiber Metal Taper stem is made of titanium alloy (Ti-6Al-4V) and has a proximal circumferential porous fiber metal coating, a corundumized surface and a distal polished part (Fig. 1). The Metabloc stem is also made from titanium alloy (Ti-6Al-7Nb) and its fully porous coated (Fig. 2).



Fig. 1. Fiber Metal Taper stem. Fig. 2. Metabloc stem.

In all cases spinal anesthesia was used. Patients were lying dorsally and we performed the hip replacements using a direct lateral Hardinge approach. All patients received first generation (Cefazolin) or second generation (Cefuroxim) cephalosporins until day 5 after operation and we used LMWH (Enoxaparine, Clexane®), for a period of 35 days after surgery for deep vein thrombosis prophylaxy. Ambulation started 3 weeks from surgery in all cases, regardless the stem type. All patients in the study went back to full activities within 3 months postoperatively. At the time of DXA analysis all patients were able to walk without a cane or any other support.

For the DXA analysis we used a Lunar Prodigy Advance Scanner and the orthopedic software. The BMD was measured around the femoral stem using the 7 zones, called regions of interest (ROI) as described by Gruen [7]. The placement of the interest zones was standardized. Each measured $1/0.5 \text{ cm}$ (0.5 cm^2) (Fig. 3).

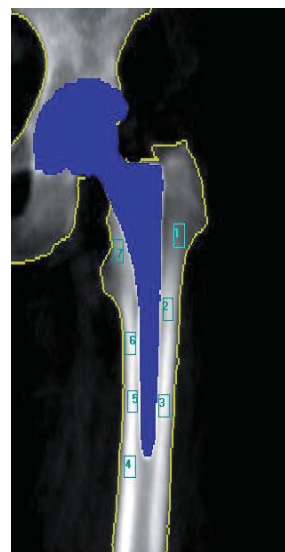


Fig. 3. DXA scan with standardized Gruen zones.

We scanned for each patient both the operated femur and the contralateral one for comparison at 1 year after hip replacement surgery.

For statistical analysis of the data we used the Kruskal Wallis test.

Results

The results were calculated in mean percentage changes comparing the operated side to the contralateral one for each ROI in both groups.

For the Fiber Metal Taper stem there was a decrease in BMD in all regions except for ROI 4 where there was a slight increase, but only in regions I, II and VII the changes were statistically significant (Fig. 4). In Gruen zone 1 the mean decrease was of 25.21% ($p=0.019$) compared to contralateral hip. In zone 2 the mean decrease was of 15.43% ($p=0.042$) and in Gruen zone 7 the decrease was 33.02% ($p=0.002$).

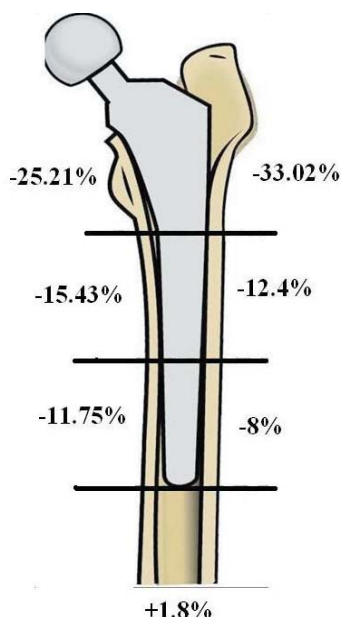


Fig. 4. BMD changes around the FMT stem.

For the Metabloc stem there was a decrease of BMD in all Gruen zones, but only in ROI 2 the changes were statistically significant ($p=0.008$) (Fig. 5).

The overall mean change in BMD for the Fiber Metal Taper stem was -14.85% compared to the contralateral femur and for the Metabloc stem was -10%. The biggest difference between the two implants was seen in ROI 7 where the bone loss around the FMT stem was 33.02% and for the Metabloc stem was only 8.33%.

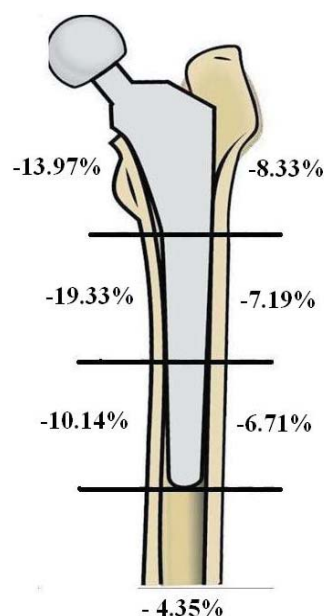


Fig. 5. BMD changes around the Metabloc stem.

Discussion

Femoral bone remodeling is a known phenomenon after cementless THA and has received much attention [1,5]. It is due to distal load transfer between the prosthetic component and the host bone and represents different amounts of bone loss. It can lead to periprosthetic fractures and loosening [1]. Factors influencing this stress shielding are various: sex, age, weight, body mass index, bone mass, and stem design [3,8]. DXA is a precise method for analyzing bone mass and small changes in bone mineral density around femoral implants after THA [3,6]. Taper-design stems were designed to achieve metaphyseal fixation with proximal load transfer to limit stress shielding [8].

We used DXA measurements to assess bone remodeling around two different cementless stems 1 year after operation in order to observe the differences between a proximally coated and a fully coated implant. Proximally coated stems are thought to be better in terms of preserving distal BMD because of proximal load transfer, thus only the calcar region (Gruen zone 1) and trochanteric region (Gruen zone 7) are stress shielded. For fully coated stems all the femur around the implant is theoretically bypassed by the natural load forces and BMD can decrease in all Gruen zones. Our findings are interesting. For the proximally coated implant, the FMT stem, bone loss was predominantly seen in the proximal zones, ROI 1 and 7, this demonstrating the theory of proximal stress shielding. For ROI 2 and 6, there was also a bone loss but with a smaller degree. More distally, for regions 3 and 5 there was also BMD decrease even if here the stem is polished to avoid bone ingrowth and limit stress shielding. Only at the tip of the stem, in Gruen zone 4 there was a slight BMD increase, probably because here the load forces are transferred to the bone.

For the Metabloc stem the stress shielding was more evenly distributed. The overall bone loss was smaller for the fully coated stem but the significance of this 5% difference is unknown.

Femoral BMD decrease is a common finding after total cementless hip replacement with different degree. Our results, varying from -33.02% to + 1.8%, are within the range of most other published studies [9-11,14-16]. To our knowledge this is the first study comparing these two implant designs. Some concerns were raised with extensively porous coated femoral stems due to stress shielding, osteolysis and high incidence of thigh pain [18]. In our series we did not find this to be an issue, moreover, the DXA results are in favour of the fully porous coated stem.

This study shows the importance of the stem design in the bone remodeling phenomenon. Even if the long term results are very good with cementless stems, much effort has been allocated for designing a femoral component that can overcome the problem of stress shielding while maintaining a secure fixation [1].

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