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Effect of proximal femoral osteoporosis on cementless hip arthroplasty: A short-term clinical analysis*

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Abstract: Objective: The aim of this retrospective investigation was to explore the influence of femoral osteoporosis on short-term curative effects of cementless hip arthroplasty and to evaluate the femoral metaphyseal bone mineral density (BMD) for femoral osteoporosis in order to guide prosthesis choice and rehabilitation. Methods: We performed 127 total arthroplasty operations between June 1999 to February 2003 and investigated 49 cementless hip replacements with the Metalcancellous cementless Lubeck II system being used in all hips. There were twenty men and twenty-nine women whose mean age at the time of the operation was 60 years (range, 52~81 years). The patients were divided into osteoporosis or normal groups according to the femoral metaphyseal BMD measured preoperatively. The average duration of follow-up was 30 months (range, 8~52 months). We evaluated all of the patients from a clinical standpoint with use of a standard-terminology questionnaire with respect to the short-term curative effects and patients' satisfaction. Hip pain status and functional ability were important indicators of treatment efficacy. Results: Harris hip score and patients' satisfaction in femoral osteoporosis patients who underwent noncemented hip arthroplasty were lower (P=0.004, P=0.03) while the incidence of thigh pain was higher (P=0.03) than the patients with non-osteoporosis. Conclusion: The higher incidence of pain, as well as the decrease in function experienced by the patients in osteoporosis group, supports the case that cementless arthroplasty is not a better choice for those patients and that we had better select prosthesis based on the femoral metaphyseal BMD.

Key words: Cementless hip arthroplasty, Osteoporosis, Bone mineral density (BMD), Curative effect
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INTRODUCTION

Cementless total hip arthroplasty (THA) is a reliable procedure for treatment of degenerative joint disease (Engh *et al*., 2001; Xenos *et al*., 1999). The primary advantage of biological fixation of cementless femoral prosthesis with porous prosthesis is the avoidance of use of acrylic cement. Gui *et al*.(2002) reported that in some cases noncemented prosthesis was preferred because of its initial stability and they found that some patients could resume standing immediately after operations.

Gui *et al*.(2000a) described 121 patients who underwent cementless hip placement in their average 3.5 years follow-up clinical investigation. In their investigation, they found that the cortical index (CI) was lower than 2.2, Harris scores and patients' satisfactions were lower but pain was more significant and prolonged. They thought CI was a reliable semi-quality parameter for clinical evaluation of femoral quality. In another study (Gui *et al*., 2002), they considered femoral metaphyseal bone mineral density (BMD) was a better parameter for evaluating femoral quality in some circumstances. How the femoral metaphyseal BMD influenced the short-term results of cementless hip replacement of the patients with femoral osteoporosis? The purpose of the study was to investigate the influence of the femoral os-

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teoporosis on short-term curative effects of cementless hip arthroplasty and to evaluate the femoral mataphyseal BMD for the patients with femoral osteoporosis in order to guide prosthesis choice and rehabilitation.

MATERIALS AND METHODS

Study population

We surveyed one hundred twenty-seven patients who had received hip arthroplasty in our hospital from June 1999 to February 2003. Forty-nine patients who had undergone cementless hip arthroplasty were included in this study. The patients were 20 men and 29 women whose average age at the time of arthroplasty was 60 years (range, 52~81 years). The preoperative diagnoses of these patients were fracture of the femoral neck in 24 hips, aseptic femur head necrosis in 12 hips and hip osteoarthritis in 13 hips. The inclusion criteria were primary hip arthroplasty, no perioperative complications, no metabolic changes causing a reduction of BMD, and no previous use of drugs affecting bone metabolism such as steroids, calcitonin, or biphosphonates. All women were postmenopausal. Details of the patients are given in Table 1. Informed consent to the study was obtained from all patients. The average follow-up time was 30 months and a retrospective analysis was conducted on those patients with or without osteoporosis in femur.

Table 1 Demographic characteristic of the patients

Variables	Normal group (n=28)	Osteoporosis group (n=21)
Age (years)	59 (12)	61 (15)
M/F	10/18	10/11
Weight (kg)	60 (13)	56 (11)
Follow-up time (months)	31 (5)	29 (7)
Stem size (n)		
100 mm	6	4
110 mm	10	8
120 mm	8	6
130 mm	4	3
Extensively coated stem	16	13
Proximally coated stem	12	9
Diseases		
Femoral neck fracture	14	10
Sepsis femur head necrosis	6	6
Hip osteoarthritis	8	5

Data are expressed as mean (*SD*) and count as appropriate

Measurement of proximal femur BMD

The femoral metaphyseal BMD was determined with dual energy X-ray absorptiometry (DXA) (XR-36, Norland Company, USA). Computer software (prosthetic scanning software version 5.73; Hologic Inc., Waltham, MA, USA) was used to measure the femoral metaphyseal bone mineral content and BMD in the regions of interest. The patients were placed supine on the scan table with standard knee and foot supports to place the femur in a neutral position. In our institution, the precision error of the calculations by DXA was less than 5%. The normal BMD was defined when the femoral metaphyseal BMD was more than 1.06 g/cm referred to the values of 1246 Chinese people in the site obtained by the East Chinese Hospital (Gui *et al*., 2002). All patients were divided into two groups according the BMD (normal group and osteoporosis group).

The prostheses used in the operation were the Metalcancellous Cementless Lubeck II system (S & G; ESKA, Lubeck, Gemany) (Matsui *et al*., 1998; Plötz *et al*., 1992; Sugano *et al*., 1994). In the system, the stem and metal socket of the implant are made of cobalt-chrome-molybdenum alloy with a metal cancellous structure. In the operation, either extensively coated stem or proximally coated stems were used. The proximally coated stems had a porous surface applied circumferentially to the proximal 60%. The stem size used for the patients ranged from 100 to 130 mm in length with 10-mm intervals. The cylindrical diameter of the stem at 1 cm above the tip ranged from 9.5 to 13 mm. The operation was performed via a posterolateral approach using standardized techniques by a single hip surgeon. Patients were allowed to start partial weight-bearing at 1 week postoperatively. Full weight-bearing was allowed at 3 week.

Harris score for evaluating arthritis of the hip (Harris, 1969)

The Harris score was developed to assess patients with traumatic arthritis of the hip. It can be used to follow patients over time and to help plan management including the timing for surgical intervention. It can be used to assess patients before and after surgery to determine improvement. The arthritis of hip was assessed in the following four aspects: pain, function, absence of deformity and range of motion

including 10 items of pain, limp, support, distance walk, stairs, shoes, sitting, public transportation, absence of deformity and range of motion. The maximum point was 100 (pain 44, function 47, absence of deformity 4 and range of motion 5) and the goal is to have a value as close to 100 as possible. However, the point of more than 80 was defined as excellent when evaluating curative effects after hip arthroplasty in clinical conditions (Gui *et al*., 2000a). We evaluated the thigh pain using Harris pain scale (Table 2).

Table 2 Harris pain score and scale

Finding	Points	Scale
None or ignores it	44	I
Slight occasional no compromise in activity	40	I
Mild pain no effect on average activities rarely moderate pain with usual activity may take aspirin	30	II
Moderate pain tolerable but makes concessions to pain; some limitations of ordinary activity or work; may require occasional pain medicine stronger than aspirin	20	III
Marked pain with serious limitation of activity	10	VI
Totally disabled crippled pain in bed bedridden	0	VI

The patients' satisfaction was evaluated as good (no problem), moderate (minor problems, but easily managed) or bad (significant problems).

Statistical analysis

All data were expressed as means (*SD*) and count (*n*) as appropriate except for special indication. Averages were compared by the Mann-Whitney U test and counts or proportions by using the Fisher's exact test. All statistical analysis was performed using SPSS 11.0 (SPSS Inc., Chicago, IL). A significance level of 0.05 was used for all analysis.

RESULTS

There were no significant differences between normal and osteoporosis group with regard to the male-female ratio, average patient age, average follow-up time, or weight. We could not detect a significant difference with regard to the stem size and proportion of extensively coated stems to proximally coated stems between the two groups (Table 1). In addition, no prosthesis loosening was observed in either group at the latest follow-up evaluation.

Comparing the two groups, we found that 86% of the patients fall in normal group whose Harris score was more than 80; while there were just 48% of the patients in the osteoporosis group. There was a significant difference (P=0.004) (Table 3). There were significant differences between the two groups with regard to the rate of the patients who had thigh pain (35% for normal group and 71% for osteoporosis group; P=0.03) (Table 4). Table 5 shows that the patients who felt good in normal group were greater than that in osteoporosis group (64% for normal group and 29% for osteoporosis group; P=0.03).

Table 3 Harris score versus proximal femur BMD

Group	Harris score	
	≥80	<80
Normal group	24	4
Osteoporosis group*	10	11

* P=0.004

Table 4 Harris pain scale versus proximal femur BMD

Group	Harris pain scale			
	I	II	III	IV
Normal group	18	6	3	1
Osteoporosis group*	6	4	8	3

* P=0.03

Table 5 Patients' satifaction versus proximal femur BMD

Group	Patients' satisfaction		
	Good	Moderate	Bad
Normal group	18	9	1
Osteoporosis group*	6	12	3

* P=0.03

DISCUSSION

THA has become a reliable procedure offering pain relief and increase in the range of motion with stability of the hip joint (Callaghan *et al*., 2000; Engh *et al*., 1997; Xenos *et al*., 1999). The implantation of a stem alters the mechanical load environment in the host bone; it takes away a relatively larger share of the load from the femur. Once the stem has been inserted,

the stress that would normally be borne by the bone alone is reduced, which leads to proximal femoral bone resorption. This resorption phenomenon around the femoral stem is called "stress shielding", which is one of the major complications of cementless THA (Bobyn *et al*., 1992; Lord *et al*., 1988). The potential complications resulting from stress shielding include thigh pain, late stem loosing and femoral fracture in the revision surgery.

Our finding of reliable short-term curative effects of cementless hip replacement is consistent with the work of Gui *et al*.(2000a). In 1987, Decker (1987) inserted a total of 72 cementless isoelastic hip prosthesis in 33 cases of loosening of various prosthesis models and in 39 cases of femoral stem fracture. Aside from one late infection, no renewed loosensings have been observed. Spicer *et al*.(2001) showed that osteolysis was noted in six patients (7%) undergoing cementless THA but predominantly in relation to the femoral stem. Fecal pelvic osteolytic lesions were rare. All the cups were classified as stable on radiography. There has been some concern regarding cementless THA femoral fixation in the elderly patient population. Berend *et al*.(2004) investigated the outcomes of a tapered cementless femoral compartment in elderly patients 75 years of age and older and found that no periopeartive deaths or significant orthopedic complications identified at a mean follow-up of 5 year. So they concluded that advanced age is not a contraindication for tapered cementless THA. However, Learmoth and Spirakis (1994) recommended a cementless hip replacement for the very young, hybrid replacement (cemented stem, uncemented cup) for the middle-aged and a fully cemented replacement for the elderly. In recent studies Roth *et al*.(2006) and Peter *et al*.(2006) showed that the cemented prosthesis should be implanted in cases with known severe osteoporosis of the proximal femur.

Gui *et al*.(2000b) investigated the relation between the femoral metaphyseal bone mineral density, Singh index, the bone mineral density of other area and biomechanical properties and found that femoral metaphyseal bone mineral density was highly correlated with other bone mineral density parameters, Singh index and prosthesis stability. They therefore concluded that femoral metaphyseal bone mineral density was a good parameter for evaluating femoral quality. In this study we measured the femoral metaphyseal BMD preoperatively and defined the osteoporosis according to the BMD of this area.

This study mainly aimed to explore whether proximal femoral osteoporosis influenced the short-term curative effect of cementless hip arthroplasty. The results showed that Harris score and patients' satisfaction in femoral osteoporosis patients who underwent noncemented hip arthroplasty were lower while the incidence of thigh pain was higher than the patients with non-osteoporosis, which were consistent with the results of previous study (Gui *et al*., 2000a).

Some limitations of our investigation need to be considered. In our first design we planned to survey 80 patients. But it is difficult to enroll more patients and at last we just included 49 patients. Another limitation of the study is that the follow-up was too short for evaluating the long-term treatment effect, which is more important for the patients.

Due to the higher incidence of pain, as well as the decrease in function experienced by the patients in osteoporosis group, we concluded that cementless arthroplasty is not a better choice for those patients. In addition, the investigation emphasizes the importance of the femoral metaphyseal BMD evaluation before operation and provides guidelines for selection of the hip prosthesis.

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