Cementless total hip replacement does not change bone mineral density of the lumbar spine

DEXA measurements in 50 patients

Franz Martini, Bernward Schmidt, Elisabeth Kremling and Stefan Sell

We measured the lumbar spinal bone mineral density with the dual-energy x-ray absorptiometry method, 8 days, 3 and 6 months after total hip replacement in 50 patients and found no statistically differences over time.

Orthopädische Universitätsklinik Tübingen, Hoppe-Seyler-Straße 3, D-72076 Tübingen, Germany
Tel +49 7071-296685. Fax -294091
Submitted 95-08-15. Accepted 96-03-28

Total hip replacement (THR) leads to a reduction of bone mineral density (BMD) in the proximal femoral shaft (McCarthy et al. 1991, Kiratli et al. 1992, Dickob et al. 1993, Kilgus et al. 1993, Trevisan et al. 1993, McGovern et al. 1994), but not distal to the arthroplasty (Adolphson et al. 1993). A recent study by Adolphson et al. (1994) described a loss of up to 8% BMD in the spine within 6 months after THR, but no loss within the first 3 months.

We examined the influence of THR on BMD of the lumbar spine 3 and 6 months after the operation.

Patients and methods

21 women and 29 men were examined (Table 1). They had a cementless custom-made femoral stem (Evolution K type, Fehling, Karlstein, Germany) with a porous-coated Harris-Galante I acetabular cup implanted via a lateral approach, according to Bauer et al. (1979) without trochanteric osteotomy. Indications for operation were arthrosis (29), arthrosis secondary to hip dysplasia (9), idiopathic aseptic necrosis of the femoral head (8) and others (4). Patients with increased bone metabolism (rheumatoid arthritis, renal dysfunction, intestinal malabsorption, postmenopausal osteoporosis), as well as patients with an intake of drugs with catabolic effects on bone (corticosteroids, long-term heparin therapy) were excluded from the study. Patients were mobilized from the second postoperative day. There were no complications—in particular, no longer periods of immobilization were necessary.

BMD-measurements were carried out by a single examiner, using the same apparatus and set-up, at 1 week, 3 and 6 months (on average 8, 86 and 180 days) after THR. BMD of the lumbar vertebral bodies 2, 3 and 4 were measured in the anteroposterior direction using the DEXA method with the patient lying in the supine position. We used a DPX-L bone densitometer (Lunar Corporation, Madison, Wisconsin, USA) and the usual measuring technique (Mazess et al. 1989, Sartoris and Resnick 1990).

In 13 patients, immediately before the operation an assessment was carried out for comparison to the postoperative BMD values of the lumbar spine.

Statistical analysis was performed using Wilcoxon's non-parametric test for the comparison of BMD values. Data for men and women were analyzed separately. The chosen level of significance was $p < 0.05$.

Table 1. Patients. Values are median (range)

Sex	n	Age	Height (cm)	Weight (kg)
Women	21	54 (34–64)	162 (148–172)	71 (52–90)
Men	29	52 (27–62)	174 (158–182)	79 (54–98)

Results

A maximum difference of +0.5% to −1.0% in BMD was seen after 3 and 6 months, respectively (Table 2). The assessment of results, with the exception of the age distribution, leads to a standard distribution. Thus no significant differences could be detected. Due to the wide age dispersion of the group of patients, comparison of BMD levels in g/cm^2 may be incorrect since BMD levels are age-dependent. Therefore BMD values were converted into age-adjusted values

Table 2. Lumbar vertebral bone mineral density (g/cm^2; BMD) 8 days, 3 and 6 months after cementless total hip replacement

Vertebral body	Sex	BMD 8 days	BMD (Δ%[a]) 3 months	BMD (Δ%[b]) 6 months
L 2	women	1.128	1.134 (+0.53)	1.129 (+0.09)
L 3	„	1.182	1.180 (–0.17)	1.170 (–1.01)
L 4	„	1.198	1.203 (+0.42)	1.193 (–0.42)
L 2	men	1.147	1.137 (–0.87)	1.142 (–0.44)
L 3	„	1.174	1.165 (–0.77)	1.170 (–0.34)
L 4	„	1.175	1.169 (–0.51)	1.166 (–0.77)

[a] Difference (3 months / 8 days) in percent.
[b] Difference (6 months / 8 days) in percent.
All differences are nonsignificant, $p > 0.05$

Table 3. Age-adjusted bone mineral density (in percent; BMD%) 8 days, 3 and 6 months after cementless total hip replacement

Vertebral body	Sex	BMD% 8 days	BMD% (Δ%[a]) 3 months	BMD% (Δ%[b]) 6 months
L 2–4	women	107.5	107.6 (+0.09)	107.0 (–0.46)
L 2–4	men	99.2	98.5 (–0.70)	98.6 (–0.60)

[a] Difference (3 months / 8 days) in percent.
[b] Difference (6 months / 8 days) in percent.
All differences are nonsignificant, $p > 0.05$

with the aid of the reference group in the DPX-L software. Conversion of BMD measured in g/cm^2 into age-adjusted percentages likewise resulted in no significant differences; it showed only a slightly higher bone density in women with a mean of 107% than in men with a mean of 99% (Table 3).

Discussion

With 3 young volunteers, Donaldson et al. (1970) showed that observance of strict bed rest for 7–8 months resulted in a monthly loss of bone density of 5–7%, measured by the single-photon absorptiometry method on the os calcis. A similar result was presented by Krøllner and Toft (1983), who showed a 4% loss of BMD per month in patients observing simple bed rest for low backache due to protrusion of a lumbar intervertebral disc, although they had an intensive physiotherapy program. Black et al. (1985) in a retrospective study with a small number of patients found—using the quantitative-computed-tomography (QCT) method—3.7 years after total hip replacement a loss of bone density of the lumbar spine only in patients with restricted mobility.

Adolphson et al. (1994) examined preoperatively the lumbar spinal BMD of 18 patients with arthrosis after THR with the QCT method. After 3 months, he noted no bone loss, whereas he found a loss of bone density of 5–8% after 6 months. This implies that during the mostly non-weightbearing or partial weight bearing period no losses occurred whereas, during the full weight bearing phase, a loss seems to have taken place. Because of 2–7% lack of precision in the measuring method, the results must be interpreted with caution.

In our study, we found no significant changes in bone mineral density in the lumbar spine 3 and 6 months after total hip arthroplasty. The maximum difference in bone density between single measurements was –1.0% to +0.5%. Taking into account the coefficient of variation and precision of the DEXA method, which was determined at 1% in vivo in our own studies and between 0.6% and 2.1% in the literature, the measured differences in BMD lie within this coefficient of variation (Mazess et al. 1989, Pacifici et al. 1990, Sartoris and Resnick 1990, Semler 1992).

Moreover, no significant differences could be found between the changes in men's and women's BMD-levels. Nor did the age-adjusted BMD show any significant difference between the women's and the men's groups. The higher age-adjusted value of 8% in the women's groups can be explained by more degenerative changes in the lumbar spine shown radiographically, but without clinical relevance.

An increase of up to 5% in BMD after 1 hour of weight training 3 times weekly has been found (Krølner et al. 1983, Dalsky et al. 1988). Our patients performed no specific exercises, except 30 minutes' physiotherapy twice weekly for the limb. After 6 weeks of partial weight bearing on the operated limb, they reached full mobility at not later than 3 months postoperatively. Therefore a substantial loss of bone density was not to be expected in any case.

References

Adolphson P, von Sivers K, Dalén N, Jonsson U, Dahlborn M. Bone and muscle mass after hip arthroplasty. Acta Orthop Scand 1993; 64 (2): 181-4.

Adolphson P, von Sivers K, Dalén N, Jonsson U, Dahlborn M. Decrease in vertebral bone density after hip arthroplasty. Acta Orthop Scand 1994; 65 (1): 12-4.

Bauer R, Kerschbaumer F, Poisel S, Oberthaler W. The transgluteal approach to the hip joint. Arch Orthop Traumat Surg 1979; 95: 47-9.

Black D M, Daniels M D, Dunn H K, Kruger R A. Computerized tomographic determination of vertebral density after total hip arthroplasty. Clin Orthop 1985; 198: 259-63.

Dalsky G P, Stocke K S, Ehsani A A, Slatopolsky E, Lee W C, Birge S J. Weight-bearing exercise training and lumbar bone mineral content in postmenopausal women. Ann Int Med 1988; 108 (6): 824-8.

Dickob M, Schittko A, Pfandl S, Wetzel R, Puhl W. Die DXA-Methode zur Quantifizierung von Knochendichteänderungen des Femurs nach zementfreier Hüftendoprothetik. Osteologie 1993; 2 (4): 206-12.

Donaldson C L, Hulley S B, Vogel J M, Hattner R S, Bayers J H, McMillan D E. Effect of prolonged bed rest on bone mineral. Metabolism 1970; 19 (12): 1071-84.

Kilgus D J, Shimaoka E E, Tipton J S, Eberle R W. Dual-energy x-ray absorptiometry measurement of bone mineral density around porous-coated cementless femoral implants. J Bone Joint Surg (Br) 1993; 75 (2): 279-87.

Kiratli B J, Heiner J P, McBeath A A, Wilson M A. Determination of bone mineral density by dual x-ray absorptiometry in patients with uncemented total hip arthroplasty. J Orthop Res 1992; 10 (6): 836-44.

Krølner B, Toft B. Vertebral bone loss: an unheeded side effect of therapeutic bed rest. Clin Sci 1983; 64 (5): 537-40.

Krølner B, Toft B, Nielsen S P, Tøndevold E. Physical exercise as prophylaxis against involutional vertebral bone loss: a controlled trial. Clin Sci 1983; 64 (5): 541-6.

Mazess R, Collick B, Trempe J, Barden H, Hanson J. Performance evaluation of a dual-energy x-ray bone densitometer. Calcif Tissue Int 1989; 44 (3): 228-32.

McCarthy C K, Steinberg G G, Agren M, Leahey D, Wyman E, Baran D T. Quantifying bone loss from the proximal femur after total hip arthroplasty. J Bone Joint Surg (Br) 1991; 73 (5): 774-8.

McGovern T F, Engh C A, Zettl-Schaffer K, Hooten J P. Cortical bone density of the proximal femur following cementless total hip arthroplasty. Clin Orthop 1994; 306: 145-54.

Pacifici R, Rupich R, Griffin M, Chines A, Susman N, Avioli L V. Dual energy radiography versus quantitative computer tomography for the diagnosis of osteoporosis. J Clin Endocrinol Metab 1990; 70 (3): 705-10.

Sartoris D J, Resnick D. Current and innovative methods for noninvasive bone densitometry. Radiol Clin North Am 1990; 28 (2): 257-78.

Semler J. Methodenvergleich der Osteodensitometrie mittels DPA und DEXA. In: Aktuelle Aspekte der Osteologie. (Eds. Ittel T H, Sieberth H-G, Matthiaß H H). Springer, Berlin-Heidelberg 1992: 465-8.

Trevisan C, Bigoni M, Cherubini R, Steiger P, Randelli G, Ortolani S. Dual x-ray absorptiometry for the evaluation of bone density from the proximal femur after total hip arthroplasty: analysis protocols and reproducibility. Calcif Tissue Int 1993; 53 (3): 158-61.