Decrease in vertebral bone density after hip arthroplasty

A quantitative computed tomography study in 18 arthrosis cases

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We investigated the bone mineral density (BMD) of the lumbar vertebrae L1–3 with quantitative computed tomography (QCT) in 18 patients who had been operated on with hip arthroplasty because of unilateral arthrosis. In an earlier prospective study, we did not find any bone mineral changes in the femur or tibia after hip arthroplasty in spite of a large increase of the thigh muscle mass as a sign of a remobilization after the operation.

The median BMD had decreased 5.3–8.4 percent in all the measured vertebrae after 6 months postoperatively. Because of the patients' improved walking ability after the operation, this decrease in cancellous vertebral BMD is interpreted as a sign of a post-traumatic osteopenia.

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Bone loss after various types of trauma has been described by many investigators (Nilsson 1966, Ahl et al. 1988, Abbaszadegan et al. 1991). However, in an earlier study of bone mineral density (BMD) in the femur and tibia after total hip arthroplasty (Adolphson et al. 1993), we were not able to demonstrate any changes in bone mass of the lower extremities after the operation. In that study the patients had a preoperative thigh muscle atrophy on the diseased side which was almost eliminated 6 months after the operation. We have now investigated whether a hip arthroplasty would induce post-traumatic osteopenia in the axial skeleton.

Patients and methods

We investigated 10 otherwise healthy women with a mean age of 74 (56–83) years and 8 men with a mean age of 70 (56–80) years who had been operated on with a cemented total hip arthroplasty because of unilateral arthrosis. They had no earlier or current disability of the contralateral leg. None of the patients underwent hormonal therapy or had any diseases known to affect the bone metabolism.

The cancellous BMD of L1–3 was measured within 1 month before the operation; in 5 patients we made 2 identical preoperative measurements, with complete repositioning of the patient and the CT scanner, within 1 week to examine the precision of the method. All patients were operated on with a cemented total hip prosthesis through a posterior incision, and the postoperative course was without complications. The same regions were scanned 3 and 6 months after the operation.

The vertebral cancellous BMD was measured by a computer tomograph (General Electric, Pace Plus™, Milwaukee, Wisconsin, U.S.A.) equipped with a bone mineral densitometry option. This software converts CT measurement numbers into equivalent bone mineral densities. It is also possible to calculate a specific subarea of the scan. The patient was scanned while lying on a reference phantom containing calibrated densities of calcium hydroxyapatite (150, 75 and 0 mg/cm^3) in a flexible water-equivalent plastic. A lateral localization scan (ScoutView™) was performed to identify the vertebrae (Figure 1). From this scan, the vertebrae L1–3 were identified and a 10-mm thick slice of their midportion parallel to the vertebra was scanned (Figure 2). From these scans, 3 circular areas (2.75 cm^2) of interest were chosen in the cancellous bone (anterior, left lateral and right lateral positions). These circular areas were placed in the purely trabecular portion of the vertebral body, avoiding the base venous complex and the cortical rim (Genant et al. 1987). The mean value of these 3 circles was estimated as the cancellous vertebral BMD in that vertebra.

The accuracy of the method has earlier been established by measuring the cortical BMD in bovine femo-

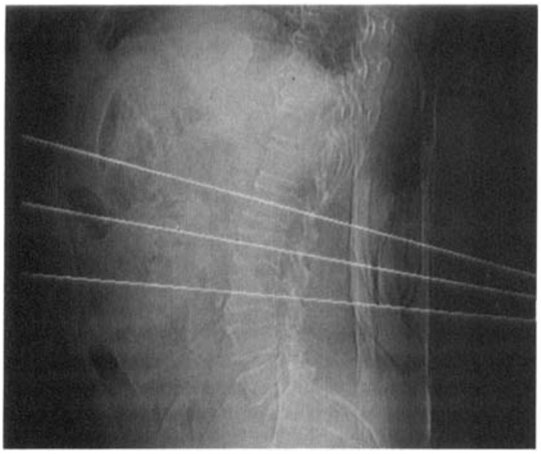

Figure 1. Localization scan ("ScoutView").

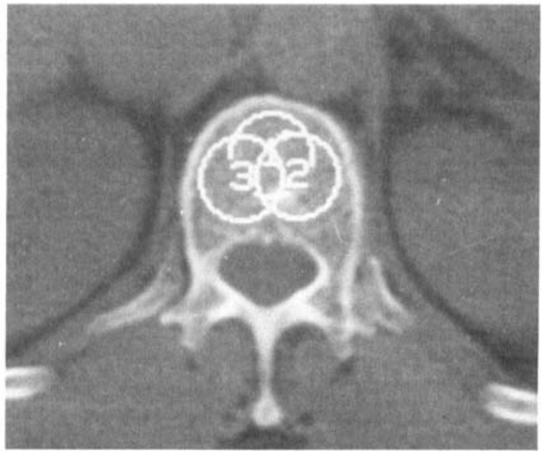

Figure 2. Scan through the middle of vertebra L1.

ral diaphyses (Adolphson et al. 1993). The mean *SD* accuracy of cortical bone was found to be 0.27 *4.41* percent.

To check the precision of the method, we made double measurements preoperatively in 5 of the patients. The precision error of our method in this study, median (25–75 percentiles), was 5 (1.3–6.1) percent in BMD of the cancellous bone in L1, 2 (1.2–3.4) percent in L2, and 7 (1.9–8.4) percent in L3.

The Wilcoxon signed-rank test was used to analyze the longitudinal changes in each vertebra. The analyses were performed on a Macintosh® II computer with the statistical package StatView SE + Graphics™. Differences were considered significant at P-values < 0.01.

Results

No significant changes were present after 3 months in vertebrae L1 and 2 (Table 1). After 6 months BMD had decreased 8.4 percent in L1 (P 0.003), 5.3 percent in L2 (P 0.002), and 5.9 percent in L3 (P 0.004).

Table 1. Cancellous bone mineral density (BMD) of the vertebrae L1–3 in 18 patients with coxarthrosis. Median values. – sign indicates bone loss. Differences in median percent

	Preop	3 months	6 months
L1	75.8	75.8 (–0.7)	71.7 (–8.4)[a]
L2	75.2	74.4 (–1.8)	68.9 (–5.3)[a]
L3	75.9	76.2 (±0)	73.4 (–5.9)[a]

BMD (mg × cm^{-3}). [a] $P < 0.01$.

Discussion

Bone mineral measurements of the axial skeleton by QCT after operative trauma have been only briefly studied (Black et al. 1985). However, the method has been extensively used to assay bone mineral (Cann et al. 1980, 1985, Genant et al. 1985), to examine the vertebral trabecular BMD in postmenopausal women, and to monitor antiresorptive treatment (Bhasin et al. 1988). The changes we found after the operation were similar on the 3 vertebral levels. For longitudinal studies, however, to improve the precision, BMD should always be computed on the same vertebra.

Post-traumatic changes may develop in locations distant from the trauma. Thus, Einhorn et al. (1990), using histomorphometry, found an osteogenic response in rats (both tibiae) when the femur on one side was fractured and fixated with an intramedullary nail. In women, Westlin (1974) found a bone loss of 10 percent of the uninjured forearm after a Colles' fracture and this indicates a purely systemic post-traumatic effect. Bone loss has also been demonstrated after soft tissue operations. Thus, Nilsson and Westlin (1969) found that patients operated on for an injury of the semilunar cartilage had a bone loss of 9 percent in the distal femur.

In an earlier study of BMD in the lower extremities after total hip arthroplasty (Adolphson et al. 1993), we did not find any decrease in bone mass. An explanation of this difference could be that a post-traumatic decrease in the BMD in the lower extremities is counteracted by the patients' increased mobility after the arthroplasty operation.

Black et al. (1985), in a retrospective study, investigated vertebral BMD by QCT on the average 3.7 years after total hip arthroplasty. They were not able to demonstrate any differences in BMD of the vertebrae T12–L2 between operated patients, preoperative coxarthrosis patients or controls. However, they found decreases in BMD in a subgroup of operated patients with poor activity levels after the operation. An explanation of the disagreement between the results by Black et al. (1985) and our results could be that they measured the vertebral BMD several years after the operation and any post-traumatic effect could have subsided. Another possible explanation could be that Black et al. (1985) performed a cross-sectional study which was not sensitive enough to reveal the small losses found in our longitudinal study.

Acknowledgements

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