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CLINICAL STUDIES

Differences in zinc status between patients with osteoarthritis and osteoporosis

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Abstract

Zinc has been suggested to play an important role in the development of osteoporosis, whereas the influence of zinc on osteoarthritis has attracted much less attention. The aim of the study was to investigate and compare the zinc status and bone turnover, density, and biomechanical properties of osteoarthritic and osteoporotic patients. The study comprised 40 women who underwent hip replacement due to osteoarthritis or osteoporosis. Serum and urine zinc content, and bone resorption markers and serum bone formation markers were determined. The unaffected hip and the exarticulated affected femoral head underwent DEXA scanning. Bone biopsies were obtained from the femoral heads and the biomechanical properties were determined. The biopsies were ashed and the bone zinc content was ascertained. Osteoarthritic patients had significantly higher serum zinc concentrations and lower urine zinc concentrations than osteoporotic patients, whereas the bone zinc content did not differ. The zinc status was not found to be a predictor for the bone strength. In conclusion, the finding that the zinc status of osteoporotic patients is significantly different from that of osteoartritic patients is new and supports the view that osteoporosis and osteoarthritis rarely occur in the same individual.

Keywords: Zinc; Osteoarthritis; Osteoporosis; Bone strength; Bone density

Introduction

Zinc has been demonstrated to be essential for normal growth of the human and animal skeleton and to play an important role in bone metabolism [1–7]. The concentration of zinc in bone is higher than in most other tissues [8,9]. Clinically, zinc deficiency is known to be associated with retarded growth, alopecia, dermal lesions, and hypogonadism. Congenital skeletal disorders, spontaneous abortion, and foetus mortus are seen to be associated with maternal zinc deficiency [3]. It has been suggested that zinc plays an important role in the development of osteoporosis [10–16] and osteoporotic fractures [17,18], whereas the influence of zinc on osteoarthritis has attracted much less attention [19].

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Although osteoporosis and osteoarthritis are both common conditions with highly age-related prevalence, a large variety of intrinsic and extrinsic factors are involved in both diseases. The most striking clinical observations are the general absence of osteoarthritis in the femoral head excised during the treatment of osteoporotic fractures [20,21], and the rarity of hip fractures caused by minimal trauma in generalized osteoarthritic cases. Osteoporosis is usually accepted as a disease of bone; the gradual loss of bone material weakens the bone, increasing the susceptibility to a fracture significantly. Although osteoarthritis is traditionally considered to be a disorder of chondrocyte function, and therefore a disease of articular cartilage, there is increasing evidence that the bone density and stiffness is abnormal, and that the disease might initially be a subchondral bone disease rather than a cartilage disorder [22–25].

The purpose of the study was to investigate and compare the zinc status and bone turnover, density, and biomechanical properties of osteoarthritic and osteoporotic patients undergoing hip replacement.

Methods

Patients

The study comprised 40 women, aged 70.4–91.3 years. These patients underwent either a total arthroplasty for osteoarthritis ($n = 20$, aged 71.7–89.6 years) or a hemiarthroplasty following a fractured femoral neck due to osteoporosis ($n = 20$, aged 70.4–91.3 years). For all patients, the diagnosis was made based on the findings of roentgenograms. Cases with roentgenographic, biochemical, or histological evidence of osteomalacia, myeloma, rheumatoid arthritis, or secondary osteoporosis due to corticosteroids were excluded from the study. The age, weight, medicine use, and disease status of the patients were recorded. Selected patient data are shown in Table 1.

Table 1. Patient data.

	Osteoarthritis	Osteoporosis	p-Value
Number of patients	20	20	–
Age (years)	77.65 ± 4.97	81.95 ± 6.02	0.018
Height (cm)	160.3 ± 6.0	163.1 ± 5.3	NS
Weight (kg)	71.9 ± 16.9	59.6 ± 10.8	0.012
BMI (kg/m^2)	27.9 ± 5.9	22.4 ± 3.8	0.0016
Femoral head dimensions			
Anterior–posterior (mm)	46.8 ± 3.3	45.8 ± 2.6	NS
Inferior–superior (mm)	47.4 ± 3.7	45.5 ± 2.9	NS

All patients gave written informed consent for tissue obtained during the operation to be used for research purposes. The project was approved by the Local Ethics Committee, and registered at ClinicalTrials.gov with NCT00317863 as ClinicalTrials.gov identifier.

Bone sample preparation

During the operation the femoral heads were obtained and the spatial orientation was marked with electrocautery. After the operation, the femoral heads were stored in sealed containers at −20 °C.

Subsequently, the femoral head dimensions were measured in the anterior–posterior and in the inferior–superior directions with an electronic sliding caliper. Three cylindrical bone biopsies with a diameter of 6 mm were obtained from each femoral head by drilling the femoral head perpendicular to the articular surface with an electrical drill with a trephine (Fig. 1). After drilling, the biopsies were sawed using a special device for fixation in order to obtain 5-mm-long cylinders of subchondral trabecular bone samples with planoparallel ends and without cortical bone [26]. After sawing, the bone samples were stored in demineralized water at −20 °C until the biomechanical test.

Zinc content and bone markers

On the day of the operation, fasting (>10 h) blood samples and second morning void urine samples were

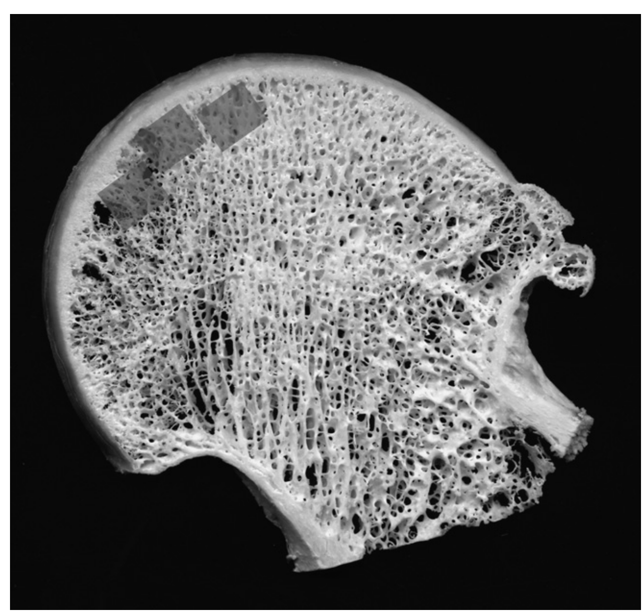

Fig. 1. Photograph of a 2-mm-thick femoral head section obtained adjacent to the bone biopsies from an osteoarthritic patient. The location of the three bone biopsies have been marked with rectangles.