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Trabecular microfractures in the acetabulum

Histologic studies in cadavers

The distribution of trabecular microfractures was studied in 39 cadaveric acetabula. The mean age of the group with microfractures was 71 years and the mean age of the group without fractures was 60 years. Most of the microfractures were located at the subchondral, weight-bearing portion of the acetabulum. Our observations suggest that trabecular microfractures are involved in the formation of bone cysts.

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Since McFarland & Frost (1961) first reported on microfractures of the trabeculae of the femoral head, most of the subsequent studies have concentrated mainly on microfractures of the same region, except some recent reports treating the vertebral bodies, but other areas have been left untouched.

Trabecular microfractures in the femoral head are regarded as fatigue fractures and thus the presence of similar microfractures in the acetabulum can be surmised since it undergoes about the same degree of stress. On the other hand, microfractures of the trabeculae may precede bone cyst formation in the aging process of the hip due to excess loading (Itoigawa et al. 1980).

The purpose of this paper was to study the existence and distribution of trabecular microfractures of the acetabulum and their possible role in the formation of bone cysts.

Material and methods

The material consisted of 39 cadaveric acetabula, including eight autopsies. The left acetabulum was observed in a total of 39 cases (24 females and 15 males), 66 (23–89) years in age. Cases with metastatic bone cancer, bone tumor and known metabolic disease, such as hyperthyroidism or hyperparathyroidism, were excluded.

The ilium, ischium and pubis were cut for resection of the acetabulum (Figure 1), which was then divided into eleven 4 mm frontal sections (Figure 2). These sections were thoroughly washed in running tap water and the blood in the marrow and the soft tissue were removed. Since in the elderly the trabeculae were often porous and scanty, there was a risk that the trabeculae could be damaged by the running water. Therefore, in those cases with porous trabeculae, the specimens were cleansed by boiling away the soft tissues in a solution of 5 per cent sodium hydroxide. Each specimen was then placed under a stereomicroscope and observations were made of the morphology and distribution of micro-

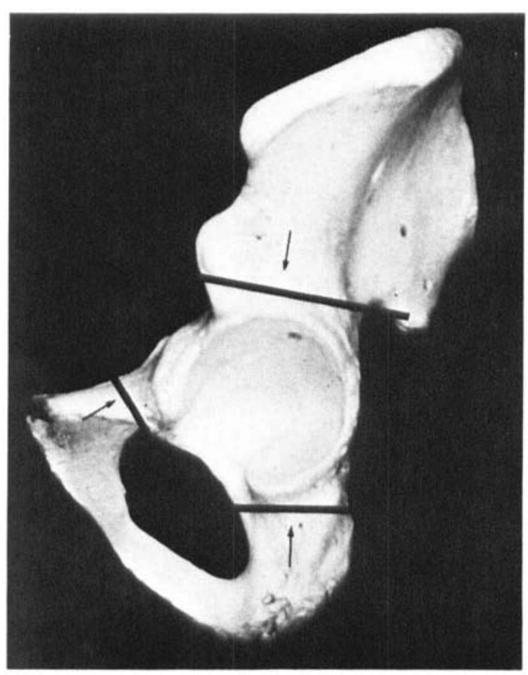

Figure 1. Method of taking specimen. Arrows indicate the three cutting lines in the left pelvis for excising the specimen.

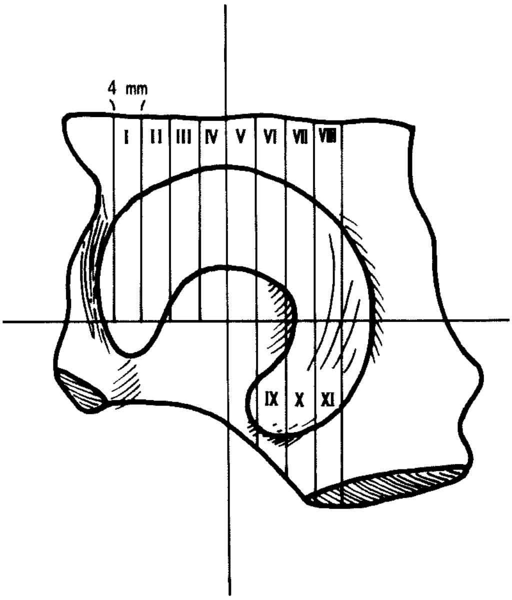

Figure 2. Method of preparing serial specimens. The specimen was cut along the horizontal line across the center of the acetabulum and then serial vertical sections were made with a width of about 4 mm; eight sections were obtained from above the horizontal line and three sections from below, which were numbered consecutively from I through XI.

Table 1. Distribution of microfractures. Seventy-four per cent of all microfractures were found in the subchondral, weight-bearing portion of the acetabulum (sections numbered III through VII)

Section	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Number of microfractures	5	7	21	19	16	20	24	12	2	13	7

fractures. From those sections in which a nodular swelling of the trabeculae indicative of a fracture was noted, smaller sections were excised including the trabeculae at the node, and both undecalcified specimens and HE-stained specimens were prepared and observed. A microradiogram was made of about 30 μm thick specimens, taking close-up photographs with a Softex CMR-2. If the trabeculae showed a nodular swelling, it was counted as a site of microfracture.

Results

Callus formation was observed in various forms, including globular, spindle, and star shapes (Figure 3). On the microradiogram the formation of callus was seen surrounding the ends of the ruptured trabeculae (Figure 4). In the HE stained specimens, trabeculae were observed almost fused surrounding woven bone as a process in fracture healing.

A total of 148 fractures were observed. The mean age of specimens in which fractures were observed was 71 years, and the mean age of specimens in which no fractures were observed was 60 years. Moreover, microfractures were observed in all specimens from 70 years and older (18 cases), but were not observed in any specimen younger than 50 (eight cases).

The fractures were found mostly in the subchondral, weight-bearing portion of the acetabulum (Table 1, Figure 5).

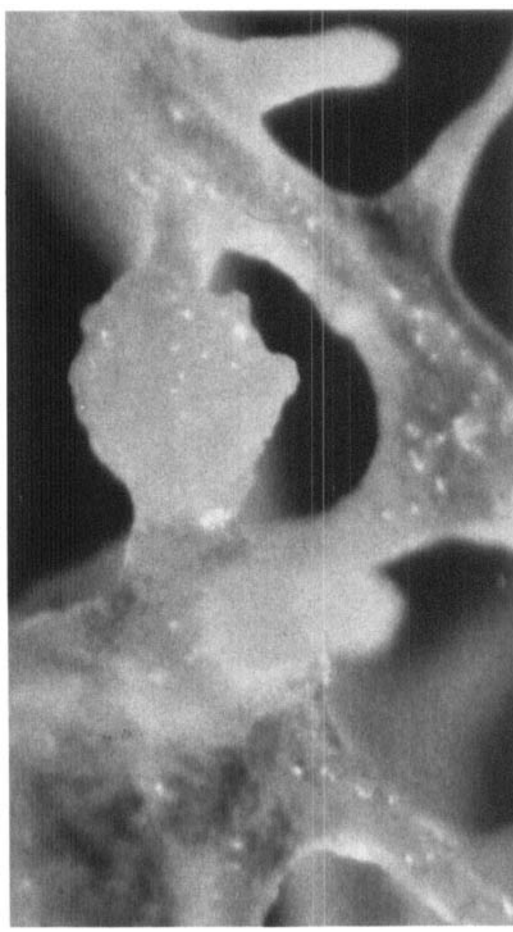

Figure 3. A trabecular microfracture (×25).

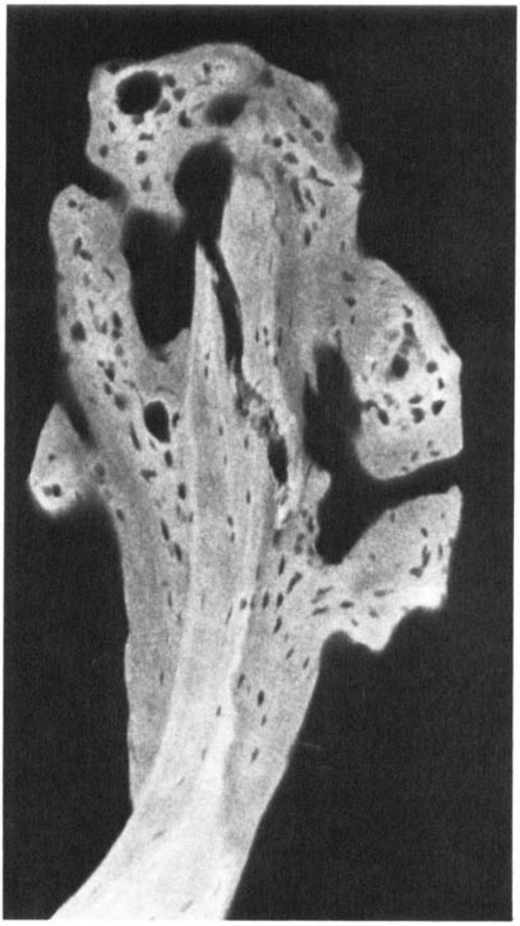

Figure 4. Microradiogram (×100). A fractured trabecula with callus formation.

Discussion

Microfractures of the trabeculae were observed in the femoral head by Todd et al. (1972), Freeman et al. (1974), Cameron & Fornasier (1975) and Urovitz et al. (1977), and in the vertebral body by Vernon-Roberts & Pirie (1973) and Kitahara (1980).

Various theories have been proposed to explain the pathogenesis of trabecular microfractures. According to Todd et al. (1972), these fractures are due to fatigue and not to excess loading or impaction, since they are usually isolated and not displaced. Freeman et al. (1974) stated, however, that the number of microfractures rose in direct proportion to the degree of osteoporosis, which is an important factor in femoral neck fractures in the elderly. With regard to the cause of trabecular microfractures in the vertebrae, Kitahara (1980) stated that the irregular distribution of microfractures in the vertebral body was not similar to that found in fatigue fractures. However, with regard to trabecular microfractures in the femoral head, the theory of fatigue fractures is generally accepted.

The trabecular microfractures in the acetabulum were concentrated in the upper lateral side, i.e., the area of the greatest stress. Eggers et al. (1963) reported that the location of bone cysts in the hip joint showed no definite tendency in the femoral head, but in the acetabulum such cysts developed in the postero-inferior region of the anterior inferior iliac spine and the juncture of the labrum and the articular cartilage or adjacent areas; the area of trabecular involvement was above the point of greatest weight-bearing pressure and this pressure point remained the same as long as the trunk was upright, regardless of the position of the femoral head. They suggested that this might explain the focal location of the acetabular cysts and the less well ordered arrangement of the cysts in the femoral head on which the weight-bearing area is more diffuse.

Studies of the femoral head in coxarthrosis

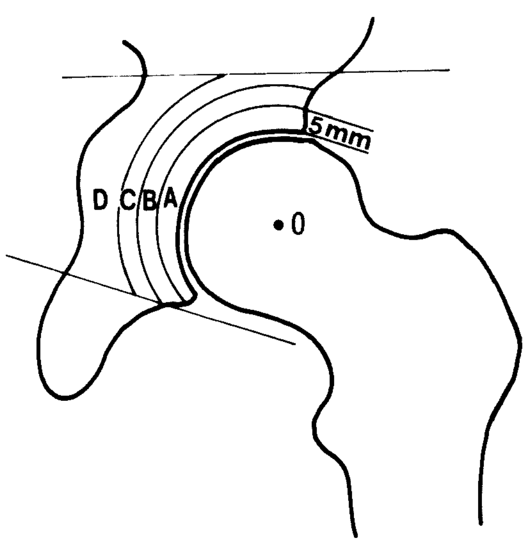

Figure 5. Distribution of microfractures. The four compartments were formed by drawing three concentric arcs from the center of the femoral head. The number of microfractures, A = 63, B = 48, C= 23, D = 7, decreased with the distance from the articular surface.

by Rhaney & Lamb (1955), Ferguson (1964), and here in Japan by Inoue (1959), Yanagitani (1962), Hirotani (1977), and Hamabuchi (1978) have shown that bone cysts develop mainly due to stress-caused trabecular microfractures.

Our study may possibly support the idea that trabecular microfractures are involved in the development of cysts in the acetabulum.

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