Cartilage injuries in distal radial fractures

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ABSTRACT Subchondral hematomas have been found with arthroscopy in one third of patients with dislocated distal radial fractures. The aim of the present, prospective study was to determine whether these hematomas might cause radiographic osteoarthrosis. We studied 41 patients (age 20–57 years, 22 women) with a dislocated distal radial fracture. At the time of fracture, 12 patients had subchondral hematomas in a radiocarpal compartment without a fracture line, as defined by arthroscopy. The 1-year follow-up included clinical and radiographic examinations.

At follow-up, radiographic subchondral bone plate changes occurred in unfractured compartments in 8 patients, of whom 7 had had a previous arthroscopically diagnosed subchondral hematoma ($p = 0.02$) in the same compartment. Of the 8 patients with radiographic changes, 4 had also developed joint space narrowing (osteoarthrosis (OA) grade 1) after 1 year and 6 after 3 years. All but 1 had had a hematoma in the same compartment. More importantly, 3 of the 16 patients with entirely extra-articular fractures had subchondral bone plate changes in a compartment corresponding to a previous subchondral hematoma ($p = 0.02$). One of these had also developed joint space narrowing. The patients with radiographic changes had a worse outcome, as measured with the Gartland and Werley wrist score ($p = 0.06$).

In conclusion, subchondral hematomas in distal radial fractures can lead to early onset of mild OA and worse outcome after 1 year.

Osteoarthrosis (OA) of the wrist, secondary to distal radial fractures, has been attributed to intra-articular incongruency (Knirk and Jupiter 1986, Kopylov et al. 1993, Trumble et al. 1994). For unknown reasons, OA has also been found following extra-articular fractures in young adults (Knirk and Jupiter 1986, Kopylov et al. 1993, Lindau et al. 2000). In other joints, acute cartilage injuries can cause changes in the subchondral bone leading to secondary cartilage degeneration (Davies 1978, Mink and Deutsch 1982, Yao and Lee 1988, Vellet et al. 1991). It has even been speculated that changes in subchondral bone may be the main cause of "idiopathic" OA, the reason being that increased stiffness of the subchondral bone increases stresses and strains in the cartilage (Radin et al. 1970).

With wrist arthroscopy as an adjunct in the management of distal radial fractures, we found various cartilage or subchondral injuries in one third of nonosteoporotic patients with dislocated fractures (Lindau et al. 1997). Cartilage injuries with subchondral hematoma may initiate a bone repair reaction, which in turn may start the OA process. In this prospective study, we tested this hypothesis by analyzing whether subchondral hematomas combined with distal radial fractures in nonosteoporotic patients lead to the early onset of radiographic OA.

Patients and methods

The patients (women 20–49 years and men 20–59 years) had an initially dislocated distal radial fracture, with at least one radiocarpal compartment free from fracture lines, as defined by arthroscopy. 41 patients (22 women) with a median age of 41 (20–57) years were included in the study. 14

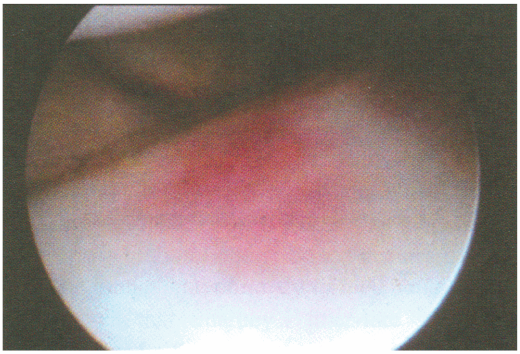

Figure 1. Arthroscopic view (dorsal aspect to the right) of a subchondral hematoma (without macroscopic damage to the cartilage) in the scaphoid facet of the radius in a left wrist. The scaphoid is seen on top, the radial styloid area at the far end and the slightly diagonal palmar radiocarpal ligaments at the palmar end of the joint surface.

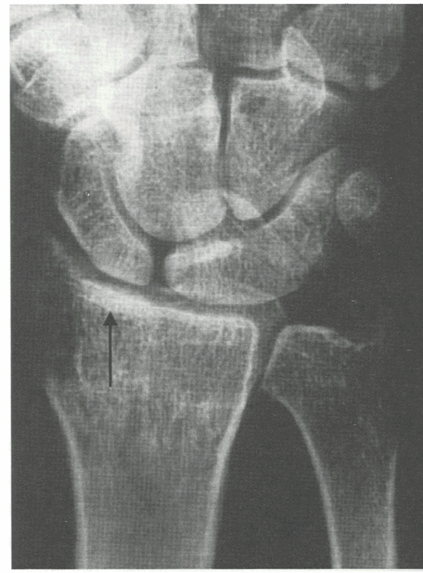

Figure 2. 1-year after an extra-articular fracture. In the scaphoid facet of the fractured radius, corresponding to the proximal pole of the scaphoid, an increased density and irregularity is seen (arrow), which corresponds to a previous subchondral hematoma at the time of fracture (Figure 1).

dominant hands were injured. 34 cases involved a severe injury—i.e., more than a simple fall on the same level (Mallmin and Ljunghall 1992).

Before fracture reduction, we found a dorsal angulation of median dorsal 18° (range palmar 25 to dorsal 45), radial length 9 (2–12) mm, radial angulation 17° (4–25) and ulnar variance 0 (–3 to +10) mm. The time-to-arthroscopy was median 3 (1–15) days after injury. The arthroscopic procedure followed the description by Whipple et al. (1986). The radiocarpal and midcarpal joints were examined, usually through the 3–4, 4–5, MCR and MCU portals. The distal radioulnar (DRU) joint was not examined arthroscopically. The examination was done following a standardized protocol. We defined the scaphoid compartment as the scaphoid facet of the radius and the scaphoid surface and the lunate compartment as the lunate facet of the radius and the lunate. A subchondral hematoma was diagnosed if the compartment had no fracture lines, the cartilage was basically normal (as opposed to avulsed) and blood/hematoma was seen through the cartilage (Figure 1).

When the radiographic outcome was related to the initial subchondral hematoma (Figure 1), only radiocarpal compartments without fracture lines were studied. Thus, in 25 patients with intra-articular fractures either the scaphoid or lunate compartment was studied and the other compartment excluded, but in 16 patients with extra-articular fractures, both compartments were taken together as one unit in the statistical analysis. At the initial arthroscopy, 12 patients had subchondral hematomas (Figure 1) without a fracture line in the compartment in the radiocarpal joint (10 in the scaphoid compartment, 1 in the lunate compartment and 1 in both). No patient showed evidence of radiographic OA at the time of fracture.

The follow-up was done after median 12 (11–27) months. The interview and physical examination were done according to the demerit point system of Gartland and Werley (1951), as modified by Sarmiento et al. (1975). This wrist score consists of a subjective opinion (0–6 p), residual deformity (0–3 p), objective evaluation (0–5 p) and complications (0–5 p). Radiograms were taken of the fractured and contralateral wrist, in neutral PA and lateral views. Radiographic osteoarthrosis (OA) was assessed and graded by Knirk and Jupiter's method (1986) (grades 0–3; where OA grade 1 means slight joint-space narrowing). The subchondral bone plate was also carefully evaluated (Figure 2). The radiographic examiner was not aware of the initial arthroscopic findings or the clinical evaluation of the patients. In cases with

Table 1. Subchondral bone plate changes in fracture-free compartments in relation to subchondral hematoma on the initial arthroscopy (p = 0.025)

Hematoma	Subchondral bone plate changes Yes	No
Yes	7	5
No	1	28

Table 2. Radiocarpal joint space narrowing (OA grade 1 (Knirk and Jupiter 1986)) in fracture-free compartments in relation to subchondral hematomas found on initial arthroscopy. Values in brackets refer to the 3-year follow-up

Hematoma	OA grade 1 Yes	No
Yes	3 (5)	9 (7)
No	1	28

Table 3. Combined radiographic changes (OA and subchondral bone changes) in extra-articular fractures (n = 16) in relation to subchondral hematomas on the initial arthroscopy (p = 0.02)

Hematoma	Combined radiographic changes Yes	No
Yes	3	2
No	0	11

joint space narrowing, it was rechecked that no such changes were present at the time of fracture. Patients with subchondral bone plate changes at the one-year follow-up were rechecked radiographically 3 years after the fracture to determine whether the changes had become worse. Arthroscopy was not performed after the fracture.

The statistical analyses were done with the Mann-Whitney U-test and Fisher's exact test.

Results

Radiographic subchondral bone plate changes with irregularities in the subchondral trabecular bone (Figure 2) were seen in 8 patients 1 year after the fracture. 7 of these had had a subchondral hematoma (Figure 1) in the same, unfractured compartment at the time of injury (p = 0.03; Table 1). The last of these 8 patients had joint space narrowing in an unfractured compartment without a hematoma. This patient had had an intra-articular fracture together with a subchondral hematoma in the adjacent compartment, but radiographic changes in both.

4 of the 8 patients with radiographic subchondral bone plate changes had also developed joint space narrowing (OA grade 1) after 1 year. 2 other patients had developed joint space narrowing at a follow-up 3 years after the fracture. 5 of the 6 cases with joint space narrowing had had a subchondral hematoma in the same, unfractured compartment at the time of fracture (Table 2).

3 of the 8 patients with radiographic subchondral bone plate changes at follow-up were among the 16 patients with entirely extra-articular fractures (Table 3). 1 of these patients also showed joint space narrowing (OA grade 1). All 3 patients had had a subchondral hematoma at the time of fracture (p = 0.02; Table 3).

Patients with radiographic subchondral bone plate changes and OA grade 1 had worse Gartland and Werley scores than the other patients at the one-year follow-up (p = 0.06, Figure 3). Apart from that, this group of patients did not have worse radiographic findings at the initial fracture (dorsal angulation, ulnar variance, radial length or radial angulation) or at follow-up.

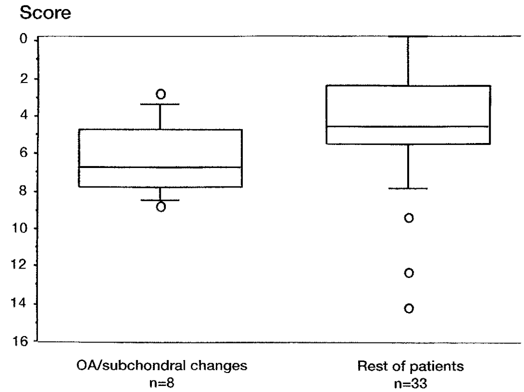

Figure 3. Patients with OA/subchondral bone plate changes had worse Gartland and Werley score (p = 0.06), than the rest of the patients at the one-year follow-up.

Discussion

We found that arthroscopically-verified subchondral hematomas (Figure 1) in dislocated distal radial fractures in nonosteoporotic patients were associated with later radiographic subchondral bone plate changes (Figure 2) and joint space narrowing as early as after 1 year. More importantly, this relation was found in 3/16 patients with extra-articular fractures alone. Our findings of cartilage injuries shed light on previous studies, in which OA has been found in up to 25% (Knirk and Jupiter 1986, Kopylov et al. 1993, Lindau et al. 2000) of extra-articular distal radial fractures. Conceivably, these patients had cartilage or subchondral bone injuries. Moreover, patients with late radiographic changes also had a worse clinical outcome (Figure 3).

The occurrence of cartilage injuries and subchondral hematomas in association with distal radial fractures has been unknown until recently (Lindau et al. 1997). With the use of arthroscopy in the management of distal radial fractures (Lindau et al. 1997), the ability to find these lesions increased. Arthroscopy is better than MRI and scintigraphy for detecting cartilage injuries in the knee joint (Adalberth et al. 1997) and this is probably also true of the wrist.

The subchondral hematomas occurred without any obvious damage to the cartilage surface on arthroscopy, and are presumably due to injuries to the subchondral bone. The development of radiographic changes after these injuries may reflect an inability to restore the subchondral bone structure after the initial repair and remodeling response. Such speculations are supported by MRI studies of the knee joint, where cartilage and osteochondral injuries have been shown to lead to osteochondral sequelae (Speer et al. 1991,Vellet et al. 1991). The injuries of the subchondral bone seem to be associated with a risk of developing a stiffer construct than normal bone, thus generating a greater load on the overlying articular cartilage (Radin et al. 1970). According to Pauwels (1976), such subchondral changes in bone changes seem to be the first radiographic signs of OA, preceding joint space narrowing. They are also thought to be a cause of OA (Pauwels 1976), and therefore not "idiopathic", but secondary to a subchondral injury. This mechanism may also explain why repetitive trauma to the joint cartilage increases the risk of OA (Davies 1978, Hadler et al. 1978, Hellman et al. 1983, Kern et al. 1988, Roos 1998).

Cartilage and subchondral bones are viscoelastic materials (Radin 1995) and their healing potential is not understood. It has been suggested that single or multiple cartilage lacerations should heal, but that the joint would undergo consistent changes if a critical threshold is passed (Mankin 1982). In our study, 3 of the 5 patients with radiocarpal subchondral hematomas in extra-articular fractures developed radiographic changes after 1 year, but 2 did not. This may indicate that subchondral bone can heal or that radiographic changes could not be seen because of the short time to follow-up.

The weakness of our study is that the radiographic changes in the subchondral bone plate were very subtle (Figure 2). However, they were found by a radiologist who was unaware of the arthroscopic findings. The relation between the initial subchondral hematoma in corresponding compartments and the radiographic changes in the subchondral bone plate, as well as joint space narrowing was statistically significant. Moreover, the findings became worse between the 1- and 3-year follow-ups. Moreover, the results are supported by one case who developed OA grade 1 during the first year after a fracture with no intra-articular involvement at all, but a subchondral hematoma in that specific compartment.

In conclusion, we have shown that arthroscopically-verified subchondral hematomas can lead to radiographic subchondral bone plate changes and early onset of OA grade 1 and a worse outcome. Consequently, posttraumatic OA after distal radial fractures can be attributed not only to joint incongruency at fracture lines (Knirk and Jupiter 1986, Kopylov et al. 1993, Trumble et al. 1994), but also to subchondral damage with grossly intact cartilage and absence of fracture lines. We plan to examine these patients after 5 years to determine whether the radiographic changes become worse.

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No competing interests declared.

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