Outcome of distal radius fractures in relation to bone mineral density

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The purpose of this study was to determine whether osteoporosis influenced the clinical results of distal radius fractures in women above the age of 40 years. Forty patients underwent bone mineral densitometry of the distal forearm, hip and lumbar spine. Radiographs of both wrists were taken at the time of fracture healing and the difference in ulnar variance, palmar tilt and radial inclination with the contralateral wrist was measured. Wrist mobility, grip strength and pain relief were determined in 35 patients with a follow-up of more than one year. We found that the clinical results correlated better with bone mineral density than with the radiological parameters. Osteoporosis may be one of the factors affecting the outcome of distal radius fractures.

INTRODUCTION

Osteoporosis can be defined as a disease with low bone mass and microarchitectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk (22). Bone mineral density (BMD) decreases with advancing age (13) and the incidence of distal radius fractures increases (15). Wrist fractures in elderly women are more communitive and displaced than in younger ones (2) and cortical bone density of the distal radius is lower in displaced than in undisplaced fractures (23).

The presence of osteoporosis may make it more difficult to obtain a good anatomical result after treatment of distal radius fractures. Osteoporotic bone has been shown to offer less fixation strength for screws than normal bone (6, 18). According to Itoh *et al* a correlation exists with loss of radial inclination and BMD after closed reduction and plaster cast immobilisation (9). Dias *et al* found that the final deformity was greater in osteoporotic fractures (3).

Various factors determine the outcome of distal radius fractures. Anatomical result, type of injury, age, level of activity, and injury compensation can all play a role (4, 14). In elderly patients with low physical demands some malunion can be accepted (10, 24).

Dual Energy X-ray absorptiometry (DEXA) is currently the most widely used method to measure BMD (16). Our study was designed to investigate the influence of BMD on the clinical results and to establish whether this influence was more important than the radiological result at the time of fracture healing.

PATIENTS AND METHODS

Women of more than 40 years old who had sustained a recent fracture of the distal radius, were asked to participate in our study. Women with bilateral fractures or a history of previous wrist fractures were excluded as were patients with high-velocity trauma fractures because of the possible higher association with cartilage or

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ligamentous injuries. Forty women agreed to undergo an additional bone mineral densitometry. The age of 40 was chosen because above this age fractures occur more frequently and osteoporosis may be present. The mean age was 64 years (range : 42 – 83).

BMD was measured with DEXA (Hologic QRD 2000, Hologic Inc., Bedford, USA) of the noninjured distal forearm, the hip and the lumbar spine. BMD of the ultra distal region of the forearm was measured separately. This is the area in which the fractures occur and the area that contains more cancellous bone than the proximal region of the distal forearm The results were presented in g/cm^2. The mean time between fracture and bone mineral densitometry was one month (range : 0 – 3.5 months).

Standard radiographs of both wrists were taken at the time of fracture healing (six weeks postoperatively). We measured ulnar variance, radial inclination and palmar tilt as described by Kreder *et al* (12). We compared the fractured wrist with the contralateral noninjured wrist. An increase or decrease in palmar tilt, ulnar variance or radial inclination was determined. In 36 patients we also measured these radiological parameters on the initial radiographs immediately after the fracture had been sustained. These radiographs were not always taken in a standardised fashion but they could give us an idea of the initial displacement.

Thirty-five patients were assessed clinically with a mean follow-up of 28 months (range : 12 - 61). Five patients were lost to follow-up. We measured the flexion-extension range, the pronation-supination range, the radial-ulnar deviation range and the grip strength of the fractured and contralateral noninjured wrist. The results of the fractured wrists were presented as a percentage of the contralateral noninjured wrists. In case the dominant hand was fractured, we augmented the grip strength of the contralateral nondominant hand with 10%.

We adapted a pain score used by Trumble *et al* (19).

The fractures were classified according to the AO classification (17). There were 20 type A or extra-articular fractures (twelve A2 and eight A3). Five fractures were type B or partial intra-articular (one B1, one B2 and three B3). Fifteen fractures were type C or completely intra-articular (seven C1, four C2 and four C3).

Five fractures were treated with plaster cast immobilisation, two with closed reduction and plaster cast immobilisation, 29 with closed reduction and percutaneous K-wire fixation, four with a palmar plate, and one with an external fixator. Treatment was performed by different surgeons. Twenty-one patients had a fracture on the dominant side and 19 on the nondominant side. The local ethics committee approved the protocol and all patients signed an informed consent form.

Statistical analysis

Spearman correlations were determined. We correlated clinical and radiological results with BMD. The correlation coefficients can have a value between –1 and +1. When the value is close to zero there is no correlation.

We also divided the group of patients into two subgroups with intra- and extra-articular fractures respectively, to have more homogeneous groups of patients. The difference between intra- and extra-articular fractures was determined with the Mann-Whitney U test.

RESULTS

The results of bone mineral densitometry are presented in table I. The radiological results are shown in table II. Clinical outcome is summarised in table III.

Correlations of clinical outcome with BMD, age and radiological results are presented in table IV. Correlation coefficients were higher when clinical results were correlated with BMD than with radiological results.

When we correlated BMD with the radiological results at the time of fracture healing we found low correlations that were not significant. When we correlated BMD with the initial radiographs, increase in ulnar variance correlated inversely with BMD of the distal forearm (R = -0.37, P = 0.03) and BMD of the ultra distal region of the radius (R = -0.40, P = 0.02). No significant correlations were found with initial difference in palmar tilt or radial inclination.

We did not find significant differences in BMD, clinical or radiological results between intra-and extra-articular fractures, but in the group of intra-articular fractures BMD and radiological parameters correlated less well with the clinical results than in the extra-articular fracture group. In patients with intra-articular fractures clinical results correlated best with BMD of the hip. We found significant correlations with grip strength (R = 0.56, P = 0.02), flexion extension range (R =

Table I. — Results of bone mineral densitometry

	Mean (g/cm²)	SD (g/cm²)	Range
BMD distal forearm :	0.43	0.06	0.28-0.54
BMD ultra distal forearm :	0.30	0.05	0.19-0.37
BMD hip :	0.79	0.11	0.57-1.02
BMD lumbar spine :	0.83	0.15	0.52-1.11

BMD : bone mineral density.

0.78, P < 0.001) and pain (R = 0.56, P = 0.02). In patients with extra-articular fractures, clinical outcome correlated best with BMD of the ultra distal region of the radius. There were significant correlations with pain (R = 71, P = 0.003), grip strength (R = 0.70, P = 0.006) and flexion extension range (R = 0.76, P = 0.001). Increase in ulnar variance at the time of fracture healing correlated significantly with pain (R = -0.75, P = 0.001), flexion extension range (R = -0.52, P = 0.04) and BMD of the ultra distal radius (R = -0.48, P = 0.04).

DISCUSSION

Our study showed that BMD had an influence on the clinical results in women above 40 with a distal radius fracture. Clinical outcome correlated better with BMD than with the radiological results at the time of fracture healing. Especially grip strength, pain and flexion-extension range correlated well with BMD. A possible explication is that fractures in patients with low BMD are initially more displaced. Pre-reduction radial shortening has been shown to give predictive information on the outcome of distal radius fractures (14). In our study initial fracture displacement (increase in ulnar variance) correlated significantly with BMD of the distal forearm and with the range of extension and flexion, and with grip strength.

It can be expected that residual fracture displacement after treatment is influenced by BMD as screw fixation is less strong in osteoporotic bone (6, 18). After closed reduction and plaster cast immobilization, loss of radial tilt correlated with BMD but not loss of palmar tilt or radial shortening (9). Diaz *et al* (3) found that osteoporotic fractures were more displaced after treatment, but a different method to determine osteoporosis was used (measurement of the cortical thickness of the second metacarpal). In our series we did not find a correlation with the final radiological result and BMD when we studied all patients, but when we looked at the extra-articular fractures separately, we found a significant correlation with increase in ulnar variance at the time

Table II. — Radiological results

	Mean	SD	Range
Initial palmar tilt (degrees) :	-27	17.8	-58 - 10
Initial radial inclination (degrees) :	-7	6.9	-22 - 15
Initial ulnar variance (mm) :	3	2.6	-2 - 11
Final palmar tilt (degrees) :	-7	12.9	-41 - 16
Final radial inclination (degrees) :	-4	4.6	-18 - 2
Final ulnar variance (mm) :	2	1.8	-1 - 7

Table III. — Clinical results

	Mean	SD	Range
Flexion extension (% affected/unaffected) :	88	11	57 - 100
Pronation supination (% affected/unaffected) :	95	11	53 - 100
Ulnar radial deviation (% affected/unaffected) :	92	18	25 - 120
Grip strength (% affected/unaffected) :	86	25	33 - 133
Pain score :	85	13	50 - 100

Table IV. — Correlations between clinical results and bone mineral densitometry, age and radiological parameters

	flex ext%	pro sup%	rad uln %	pain score	grip strength%
BMD distal forearm :	-0.54**	0.21	0.24	0.27	0.50**
BMD ultra distal forearm :	0.59**	0.24	0.27	0.42*	0.63**
BMD hip :	0.72**	0.42*	0.37*	0.40*	0.61**
BMD lumbar spine :	0.59**	0.24	0.28	0.36*	0.43*
Age :	-0.10	0.01	-0.14	-0.17	-0.29
Initial PT :	0.43*	0.32	0.06	0.21	0.26
Initial RI :	-0.10	0.21	0.17	-0.02	0.02
Initial : UV :	-0.43*	-0.28	0.03	-0.19	-0.52**
Final PT	0.11	0.18	0.33	-0.07	0.08
Final RI	0.11	-0.01	0.10	0.11	0.24
Final UV :	-0.21	-0.17	0.14	-0.24	-0.34

P < 0.05, ** P < 0.01.

BMD : bone mineral density in g/cm^2, PT : palmar tilt in degrees, RI : radial inclination in degrees , UV : ulnar variance in mm. PT, RI and UV are the difference with the contralateral uninjured wirst. flex ext : flexion- extension range of motion, pro sup : pronation-supination range of motion, rad uln : radial-ulnar deviation range of motion. The ranges of motion are presented as a percentage of the contralateral uninjured wrist.

of fracture healing and BMD of the ultra distal region of the radius.

Patients with distal radius fractures had significantly lower BMD than controls at other sites like hip and lumbar spine (15). However, Xie and Bärenholdt found that fracture displacement was not associated with general osteoporosis. They showed that cortical (not trabecular) bone density and geometric properties at the fracture site were the major determinants for displacement in distal radius fractures (23). We also found that BMD at the fracture site correlated significantly with increase in ulnar variance at the time of the accident. BMD of the hip and lumbar spine did not correlate with the radiological parameters, but did correlate with the clinical result. This may suggest that clinical outcome may be influenced by general osteoporosis. We even found that BMD of the hip and lumbar spine correlated better with the clinical outcome than BMD of the distal radius, but when we separated intra-and extra-articular fractures, we found that in extra-articular fractures BMD at the fracture site was the most important parameter.

The influence of the final radiological parameters on the clinical results in distal radius fractures has been studied extensively. Many authors have found radial shortening to be an important parameter with regard to outcome (1, 8, 11, 19, 21), whereas others have not (5, 20). In the present study we only found significant correlations between the radiological and clinical outcome in extra-articular fractures. Increase in ulnar variance was the most important parameter.

We investigated the influence of osteoporosis on the outcome of distal radius fracture in a previous study (7). We did not find significant correlations between BMD and clinical results. The reason may be that the mean time between fracture and bone densitometry was 23 months and in the present study it was one month. We only used BMD of the distal forearm and we did not separate extra-articular fractures.

A limitation of our study is that we did not have radiographs at the time of follow-up. Many elderly patients did not want to come to the hospital and were visited in their homes. Kopylov *et al* (11) reported that loss of radial length and articular incongruity correlated with clinical outcome, but most of the degenerative changes gave no complaints. We could not assess if postoperative osteoarthritis influenced the clinical results, but BMD correlated better with the clinical results than with the radiological parameters we studied, as well in intra- as in extra-articular fractures.

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