

THE ROLE OF OSTEOPOROSIS IN DISTAL RADIUS FRACTURES

N. HOLLEVOET, S. GOEMAERE¹, F. MORTIER, P. VAN BOUCHAUTE², J. M. KAUFMAN¹, R. VERDONK

Our study was designed to establish whether the degree of osteoporosis of the distal forearm affects the outcome of distal radius fractures in elderly women. We assessed the Gartland and Werley score, wrist mobility, grip strength, ulnar variance, radial inclination and palmar tilt of both wrists in 27 postmenopausal women who had sustained a unilateral distal radius fracture following a simple fall. Bone mineral density of the contralateral uninjured wrist and midtibial ultrasound velocity were measured. The Gartland and Werley score, wrist mobility, loss of grip strength and the radiological results of the fractured wrist did not correlate with bone mineral density of the uninjured distal radius or with midtibial ultrasound velocity. These results may indicate that the influence of osteoporosis on the radiological and clinical outcome in distal radius fractures is not very important.

Key words : fracture, distal radius, osteoporosis, bone mineral density, ultrasound velocity.

Mots-clés : fracture, radius distal, ostéoporose, densité minérale osseuse, vitesse de l'ultrason.

INTRODUCTION

In the literature few studies deal with osteoporosis and the radiological results of distal radius fractures. To the best of our knowledge no information is available on the correlation between bone mineral density (BMD) and clinical outcome.

Fractures of the distal radius are more common and more severely displaced and comminuted in older than in younger women (4). This might be attributed to the fact that osteoporosis is more frequent in older women and that osteoporotic bone is more fragile and susceptible to fracture (10). Older

people may also have weak arm muscles and less protective responses which may increase the severity of the fall and fracture risk (18). If osteoporosis is the main cause for increased comminution and displacement of distal radius fractures, clinical and radiological results of treatment might be worse in women with severe osteoporosis than in women with mild or no osteoporosis. To check the validity of this statement we looked for correlations between the clinical and radiological outcome of distal radius fractures with BMD and quantitative ultrasound velocity (QUS) of the tibia.

MATERIALS AND METHODS

We reviewed the records of postmenopausal women who had sustained an isolated fracture of the distal radius more than one year ago. High-velocity injuries were excluded. We contacted 118 patients by letter. Twenty-seven patients agreed to participate in the present study. Nonparticipation was due to patient refusal, loss of contact or death. The study was approved by the ethical committee of our hospital. The mean age was 67 years (range 51-78 years). Fourteen patients had been treated with percutaneous pinning, six patients had had open reduction with a plate, five patients had undergone closed reduction of the fracture and two patients had been treated by plaster cast immobilisation without

Department of Orthopaedic Surgery and Physical Medicine, University Hospital, Ghent, Belgium.

¹ Department of Osteoporosis and Metabolic Bone Disease, University Hospital, Ghent, Belgium.

² Department of Orthopaedic Surgery, St. Jozef-Kliniek, Gentbrugge, Belgium.

Correspondence and reprints: N. Hollevoet, UZ Gent, De Pintelaan 185, B-9000 Gent, Belgium.

manipulation. In 14 patients the wrist of the dominant hand was fractured and in 13 patients the nondominant hand was involved. The mean time between the wrist fracture and the present evaluation of BMD, speed of sound (SOS) and clinical and radiological results was 23 months (range : 12-69 months).

Bone mineral density

BMD of the nonfractured distal third of the radius was determined with dual energy xray absorptiometry (DEXA) Hologic QDR 2000. The results are expressed as T scores, representing the difference from the mean of young normal adults expressed in standard deviation. If the T score is superior or equal to -1.0 BMD, bone mineral density is normal. If the T score is less than -1.0 but more than -2.5, the patient has osteopenia. A T score equal to or smaller than -2.5 signifies osteoporosis (24).

Quantitative ultrasound velocity (QUS)

The cortical bone at the midtibia was evaluated with the Soundscan 2000 Myriad Ultrasound Ltd., Rehovot, Israel. The speed of sound in m/sec. along a fixed longitudinal distance of the cortical layer at the tibial shaft was measured (8).

Clinical evaluation

A modified Gartland and Werley scoring system was used (1). This score deals with subjective and objective clinical parameters (wrist mobility, deformity), and complications. Grip strength is also included in the modified scoring system. If the patients have less than 60% grip strength compared to the opposite side, then an additional demerit point is given. Patients with 2 points or less have an excellent result. Patients with a score between 3 and 8 points have a good result and patients with more than 8 points have a fair result. A criticism of this score is that it is difficult to obtain a fair or poor result. In our series the results were indeed excellent or good. To obtain better discrimination we only considered the demerit points.

The grip strength of the fractured wrist was compared with that of the nonfractured wrist and expressed as a percentage.

The mobility of both wrists was measured with a goniometer. The difference in flexion, extension, supination and pronation was noted between the normal and fractured wrist.

Radiological evaluation

At follow-up xrays of both wrists were taken in standard positions as described by Baratz and Larsen (3), and the difference in radial inclination (RI), palmar tilt (PT) and ulnar variance (UV) between the normal and the fractured wrist was measured. Assuming that both wrists of an individual are almost symmetrical (23) the difference from the normal wrist can give an idea about the deformity of the fractured wrist. A standard plastic goniometer was used and all the measurements were done by the first author. The intraclass correlation of the measurements was 0.96 for RI, 0.99 for UV and 0.99 for PT.

RI was measured according to DiBenedetto *et al.* (6), but the line bisecting the radial shaft was determined at two and four centimeters proximal to the radiocarpal joint instead of two and six centimeters because the radial shaft was not sufficiently long on all our xrays (fig. 1).

Ulnar variance is the difference in length between radius and ulna on posteroanterior views. A positive UV means that the ulna is longer than the radius and a negative UV means that the radius is projected more distally than the ulna (9). To determine the UV we first drew the central axis of the radius and then two perpendicular lines to this axis. One line was along the distal articular surface of the ulna and one line went through the lunate facet of the distal articular surface of the radius. The distance between these two parallel lines is the UV (fig. 1).

The PT was measured on lateral views as the angle between a line from the dorsal edge of the carpal surface to the palmar edge and a perpendicular line drawn to the axis of the radius (23) (fig. 2).

In 21 patients the difference in RI, UV and PT was determined between the preoperative xrays and the normal wrist. Three xrays were lacking and in three cases the radiological parameters could not be properly measured due to lack of standardisation.

Statistical analysis

Spearman correlation coefficients were calculated and the level of significance was set at $\alpha = 0.05$. The following variables were studied for significant correlations with each other : age in years, T score of the nonfractured distal forearm measured with DEXA, SOS of the tibial cortex, Gartland and Werley score (in points), percentage of grip strength compared with the normal wrist, difference in flexion, extension, pronation and supination between normal and fractured wrist and difference in PT, RI and UV on preoperative xrays and at follow-up.

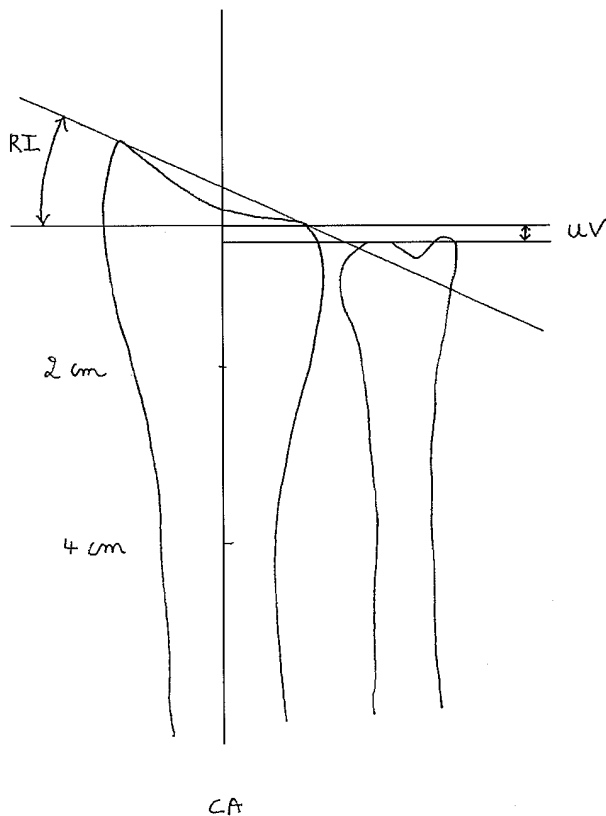


Fig. 1. — Measurement of radial inclination (RI) and ulnar variance (UV).

CA : central axis determined at 2 and 4 cm proximal to the articular surface of the distal radius.

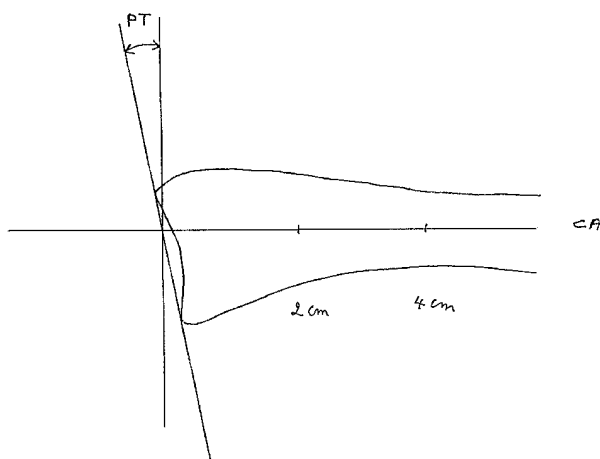


Fig. 2. — Measurement of palmar tilt (PT).

CA : central axis determined at 2 and 4 cm proximal to the articular surface of the distal radius.

In this study the greatest correlation found between the parameters that were investigated, was -0.22. For the actual sample size, supposing that the real correlation is between -0.25 and -0.2, the power is less than 0.5. If a power of 0.8 is required, the sample size should reach a number of $n = 165$. Inclusion of more patients however will not turn a correlation coefficient of $r = -0.2$, even though it is significant for $n > 165$, into a clinically meaningful correlation. The other correlation coefficients for BMD or SOS obtained in the study are weaker than 0.2 ; these results are very close to the $r = 0$ correlation under the null hypothesis and larger sample sizes will not change the conclusion that there is no correlation (15).

RESULTS

We found a mean T-score of -2.5 (range : 0.48-4.61) (SD : 1.35). Twelve patients had osteoporosis and 14 had osteopenia in the distal forearm. Mean SOS was 3897 m/sec (SD : 179.5 ; range : 3612-4338 m/sec.)

The mean Gartland and Werley score was 3.6 points (range : 0-8). Ten patients had a score of 2 points or less, which is regarded as an excellent result and 17 patients had a score between 3 and 8 points which means a good result. The mean loss of flexion of the fractured wrists was 15.5° (SD : 11, range : 0° - 40°) and the mean loss of wrist extension 6° (SD : 6.5 ; range : 0° - 20°). The mean loss of both pronation and supination was 4° , ranging between 0° and 20° (SD for pronation : 7.5, SD for supination : 7.5). The mean grip strength of the fractured wrist was 85% of the normal wrist (range : 35%-123%).

The initial radiological results before treatment and at follow-up are listed in table I and II, respectively.

Table I. — Radiological results on xrays taken before treatment (N = 21)

	mean	median	SD	range
diff. in palmar tilt (degrees)	-26	-31	20	+9 ; -73
diff. in radial inclination (degrees)	-7	-9	9.5	+15 ; -22
diff. in ulnar variance (millimeters)	2.7	2.5	2.4	0 ; +8

diff. : difference between fractured and normal wrist.

Table II. — Radiological results at follow-up (N = 27)

	mean	median	SD	range
diff. in palmar tilt (degrees)	-8	-9	11.5	+12.5 ; -36
diff. in radial inclination (degrees)	-3.5	-2.5	-2.5	+5 ; -15
diff. in ulnar variance (millimeters)	1.7	1.5	1.5	0 ; +5

diff. : difference between fractured and normal wrist.

BMD of the distal forearm correlated significantly with tibial SOS ($r = 0.43$, $p = 0.02$). Other correlations with osteoporosis parameters (BMD, SOS) and clinical and radiological parameters are listed in table III.

Table III. — Spearman's correlation coefficients of BMD and SOS with age, Gartland and Werley score, and clinical and radiological results. $n = 27$, except for initial xrays ($n = 21$)

	BMD	SOS
age (years)	-0.41*	-0.47*
demerit score (points)	-0.05	-0.04
grip strength percentage	-0.07	-0.02
diff. in wrist flexion	-0.05	-0.06
diff. in wrist extension	0.04	-0.15
diff. in pronation	-0.16	-0.08
diff. in supination	-0.06	-0.06
initial diff. in PT	-0.15	0.06
initial diff. in RI	0.11	0.08
initial diff. in UV	0.02	-0.22
diff. in PT at follow-up	-0.15	-0.09
diff. in RI at follow-up	0.1	0.00
diff. in UV at follow-up	-0.01	-0.08

Significant correlations ($P < 0.05$) are marked with *.

diff. : difference with fractured and normal wrist,

BMD : bone mineral density expressed as T score,

SOS : speed of sound at the midtibial cortex in m/s.

PT : palmar tilt in degrees, RI : radial inclination in degrees,

UV : ulnar variance in mm.

DISCUSSION

DEXA is currently most widely used for the measurement of BMD (17). The technique is based on the attenuation of ionizing radiation by the bone mineral. It is a valid method to diagnose osteoporosis

and determine fracture risk. A disadvantage of DEXA is that it provides only limited information on bone structure and bone material properties (10).

In the literature few articles deal with osteoporosis and the outcome of distal radius fractures. Milliez *et al.* (16) did not find a correlation between metaphyseal comminution and fracture displacement and degree of osteoporosis. They assessed 100 patients of whom 25 had manifest osteoporosis. They did not specify how the degree of osteoporosis was determined. Edwards (7) had no problems with pin fixation in osteoporotic patients treated with an external fixator. Osteoporosis was assessed by the cortical thickness of the metacarpal. Diaz *et al.* (5) assessed 15 men and 112 women and found that in minimally displaced distal radius fractures the initial deformity was greater in osteoporotic patients whereas in severely displaced fractures the initial deformity was not influenced by osteoporosis. Minimally displaced fractures were treated with plaster cast immobilisation and severely displaced fractures with closed manipulation and plaster cast. The loss of reduction was greater in patients with osteoporosis. The cortical thickness of the second metacarpal was used to determine if osteoporosis was present. Itoh *et al.* (12) found a correlation between loss of RI after closed reduction and bone mineral density measured with DEXA in 72 women and 23 men. There was no correlation with PT or decrease in radial length.

QUS is a relatively recent noninvasive technique to assess bone and fracture risk. It can be measured at different skeletal sites (calcaneus, tibia, patella, phalanges). The two QUS parameters currently measured are speed of sound and broadband ultrasound attenuation given in units of m/s and dB/MHz, respectively. Although there is a clear correlation between ultrasound parameters and BMD, QUS does not only reflect BMD but is thought to also give additional information about bone architecture, strength and fracture risk (19, 10, 17). Midtibial ultrasound velocity correlates with mechanical properties of cortical bone of the tibia (14). The precision of the SOS measurement is high, but its role in clinical practice still needs to

be established because of low correlation with other skeletal sites (20). Foldes *et al.* (8) found a mean value of 3867 m/s for tibial SOS in 307 patients referred to their osteoporosis center. Eighty-two percent of the patients were post-menopausal. These results are similar to the mean value in our series. This may illustrate the poor capability of SOS to discriminate between fracture and nonfracture patients.

In the present study we were not able to find correlations between the degree of osteoporosis and radiological deformity and clinical outcome. An explanation for the lack of correlation is that besides BMD additional factors like bone architecture and geometry also contribute to strength (2). The magnitude and the direction of the force on the distal radius during the fall may also play an important role in the type of resultant fracture (22), although we only included patients who had sustained low-velocity trauma. Radiological results at follow-up may further be influenced by the treatment and in the present study different methods of treatment were used. Our results are still preliminary and investigation of more patients is needed to confirm our findings.

Our patients had excellent and good Gartland and Werley scores, although some presented residual deformity. This may be explained by the fact that more than 8 points are necessary to obtain a fair result, which is rather much. If patients with a score of more than 5 points would be classified as having a fair result, we would have 10 patients with an excellent result, 11 with a good result and 6 with a fair result. This may provide a better discrimination between good and fair results. The good results can also be explained by the fact that the demands of the patients in our series were not as high as those of young active patients. The results in older people were assessed by Roumen *et al.* (21). They found no correlation between the final anatomical and functional outcome. Greeting and Bishop (11) found a greater loss of reduction in older than in younger patients who had been treated with intrafocal pinning, but there were no functional problems. In selected elderly patients dorsal angulation up to 30° and radial shortening of 5 mm may be accepted (13).

CONCLUSION

We could not find any significant correlation between bone mineral density, midtibial cortical ultrasound with the Gartland and Werley score, wrist mobility, grip strength and radiological parameters in elderly women who had sustained a distal radius fracture following a simple fall. Our results may signify that the importance of osteoporosis is not as great as expected.

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SAMENVATTING

N. HOLLEVOET, S. GOEMAERE, F. MORTIER, P. VAN BOUCHAUTE, J. M. KAUFMAN, R. VERDONK. De rol van osteoporose bij fracturen van de distale radius.

Met deze studie wilden wij nagaan of osteoporose een invloed heeft op de resultaten van distale radiusfracturen bij oudere vrouwen na een eenvoudige val. We bepaalden de Gartland en Werley-score, de mobiliteit van de pols, de grijpkracht, de radiaire inclinatie, palmaire tilt en ulnaire variantie van beide polsen bij 27 vrouwen die een unilaterale fractuur opliepen van de distale radius. De botmineraaldichtheid van de contralaterale niet gebroken distale orderarm werd gemeten evenals de ultrageluidssnelheid van de tibiale cortex. Wij konden geen significante correlatie aantonen tussen de osteoporoseparameters en de radiologische en klinische parameters van de gebroken polsen.

De resultaten van deze studie kunnen erop wijzen dat osteoporose minder invloed heeft op het resultaat van distale radiusfracturen dan verwacht.

RÉSUMÉ

N. HOLLEVOET, S. GOEMAERE, F. MORTIER, P. VAN BOUCHAUTE, J. M. KAUFMAN, R. VERDONK. Le rôle de l'ostéoporose dans les fractures du radius distal.

Cet étude a pour but de déterminer l'influence de l'ostéoporose dans la guérison des fractures distales du radius chez la femme âgée après une chute banale. Nous avons utilisé le score de Gartland et Werley, la force de préhension, la mobilité des poignets, l'inclinaison radiale, la variance cubitale ainsi que l'inclinaison palmaire des poignets, chez 27 femmes qui avaient présenté une fracture unilatérale du radius. La densité minérale osseuse du radius distal du côté non-fracturé ainsi que la vitesse de l'ultrason dans la corticale tibiale ont été mesurées.

Nous n'avons pas trouvé de corrélation significative entre la densité minérale osseuse ou la vitesse de l'ultrason dans la corticale tibiale et le type de fracture selon la classification de l'AO, les paramètres radiologiques ou le score de Gartland and Werley.

Nos résultats peuvent signifier que l'importance de l'ostéoporose est moins grande que prévue.