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The effects of osteoporosis on functional outcome in patients with distal radius fracture treated with plate osteosynthesis

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Objective: The aim of this study was to evaluate the effect of osteoporosis on functional results in patients with distal radius fracture treated with plate osteosynthesis.

Methods: The study included 37 female patients who underwent osteosynthesis using volar locking plate for distal radius fracture between 2006 and 2008. Diagnosis of osteoporosis was made with bone mineral density measurement. Patients were divided into two groups; Group 1 patients (20 patients; mean age: 56.5 years) had osteoporosis and a mean T-score of -2.6 SD, and Group 2 patients (17 patients; mean age: 37.1 years) did not have osteoporosis and had a T-score of -0.7 SD. Radiological results were evaluated according to the Stewart's criteria and activities of daily living were assessed with the modified Gartland and Werley score, the modified Mayo wrist scoring system, and the DASH scoring system.

Results: According to the Stewart's radiological evaluation criteria and modified Gartland and Werley scores, there was no statistically significant difference between Group 1 and 2 ($p>0.05$). However, a statistically significant difference was found between Group 1 and 2 according to the modified Mayo wrist scoring system and DASH scoring system ($p<0.05$).

Conclusion: There was no radiological difference between the osteoporotic and non-osteoporotic patients with distal radius fractures treated with plate osteosynthesis. However, osteoporosis had a negative effect on the results and range of motion of the wrist, and activities of daily living were significantly restricted.

Key words: Distal radius fracture; locking plate; osteoporosis.

Osteoporosis, defined as the microarchitectural deterioration of the bone accompanying decreased bone mass, is the most common bone disease.[1,2] It is a systemic skeletal disease characterized by increased fragility of the bone, i.e. increased probability of fracture occurrence during the period following this deterioration.[3-7]

Although hip and vertebral fractures are given particular importance as they are associated with higher

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morbidity and mortality, distal radius fractures are the most common type of fractures seen with osteoporosis.[8-10] It has been reported that 15% of women experience at least one distal radius fracture throughout their life.[11] Several studies have been published demonstrating a correlation between osteoporosis and distal radius fractures. Those studies showed that bone mineral density was very low,[12,13] not changed, or reduced in some regions.[10,14] Khan et al. reported that osteoporotic distal radius fractures develop secondary to low-energy trauma.[15] However, Clayton et al. reported a definite correlation between bone mineral density and the severity of distal radius fractures.[16]

The present study aimed to evaluate the effect of osteoporosis on functional outcomes of patients with fracture of the distal end of the radius treated with plate osteosynthesis.

Patients and methods

Thirty-seven female patients with distal radius fracture who underwent osteosynthesis using volar locking plate between 2006 and 2008 were evaluated. Patients underwent bone mineral density (BMD) testing at the femoral neck and lumbar spine (L1-L4) using the DEXA method following the surgery. Based on the arithmetic mean of the results, patients with a T-score of -2.5 SD and below were diagnosed with osteoporosis. Patients were then divided into two groups. Group 1 included 20 patients (9 right, 11 left fractures; mean age: 56.5 years; range: 45 to 65 years) with osteoporosis and Group 2 consisted of 17 patients (8 right, 9 left fractures; mean age: 37.1 years; range: 27 to 51) without osteoporosis (Figs. 1 and 2).

According to the AO classification,[17] Group 1 had one 23A3.3, four 23B1.2, six 23B3.3, three 23C1.2 and six 23C1.3 fractures. The mean T-score of these patients was -2.6 SD (range: -2.5 SD to -2.9 SD). Patients were operated within a mean period of 3.75 (range: 2 to 6) days following injury and mean duration of hospitalization was 7.8 (range 5 to 13) days.

In Group 2, there were one 23A3.3, six 23B1.2, two 23B3.3, four 23C1.2 and four 23C1.3 fractures. The mean T-score was -0.7 SD (range: +1 SD to -1.2 SD). Mean hospitalization period was 5.75 (range: 4 to 6) days and the mean duration between injury and surgery was 2.75 (range: 1 to 4) days.

All patients were placed into short-arm splint for 21 days after the surgery. They were followed on an outpatient basis and shown exercises to restore range of motion in their wrists. Regular polyclinic visits were scheduled for a period of 12 months.

At postoperative Month 12, radiological assessment criteria described by Stewart et al.[18] were used for radiological evaluation of patients in both groups. The activities of daily living for all patients were evaluated both objectively and subjectively using the Sarmiento's modification of Gartland and Werley scores,[19] DASH[20] and MAYO Clinic[21] modified wrist scoring systems.

For statistical analysis, SPSS 15.0 software (SPSS Inc., Chicago, IL, USA) was used. Data were evaluated using descriptive statistical methods (mean, standard deviation), as well as Fisher's exact test for comparison of two groups and the Mann-Whitney U test for the distribution of variables in scorings which evaluate activities of daily living. Results were evaluated at a significance level of $p<0.05$ and a confidence interval of 95%.

Results

Mean follow-up period was 23.75 (range: 37 to 12) months. At postoperative Month 12, anteroposterior and lateral radiographs were taken and evaluated using Stewart's radiological assessment criteria. Group 1 had 17 "excellent and good" (85%), and 3 "fair and poor" (15%) outcomes while the non-osteoporotic group (Group 2) had 15 "excellent and good" (88%) and 2 "fair and poor" (12%) outcomes (Fig. 3). There was no statistically significant difference between the two groups ($p>0.05$).

At postoperative Month 12, according to the Sarmiento's modification of the Gartland and Werley scoring system and objective evaluation of the radiographs and range of wrist motion, in Group 1 there were 18 (90%) "excellent and good", 2 (10%) "fair and poor" outcomes. In Group 2, 15 patients (88%) had "excellent and good" outcome, and 2 patients (12%) had "fair and poor" outcomes (Fig. 4). According to the Fisher's exact test, there was no statistically significant difference between the two groups ($p>0.05$). It was observed that osteoporosis had less effect on the outcome as this scoring system has radiological criteria.

According to a modification of the wrist-scoring system of the MAYO Clinic, the mean score was 62.2±8.8 (range: 40 to 80) in Group 1 while it was 84.4±15.5 (range: 40 to 95) in Group 2. Based on these results, in Group 1, 12 patients (60%) had good and 8 patients (40%) had "fair and poor" outcomes. In Group 1, no patient had an excellent outcome. In Group 2, 15 patients (88%) had "excellent and good" outcomes, and 2 patients (12%) had "fair and poor" outcomes (Fig. 5). Mean DASH score was 32.5±8.41 (range: 13.7 to 48.1) in Group 1, and 10.7±11.64 (range: 0.8 to 47.7) in Group 2 (Fig. 6). Both these differences were statistically significant ($p<0.05$).

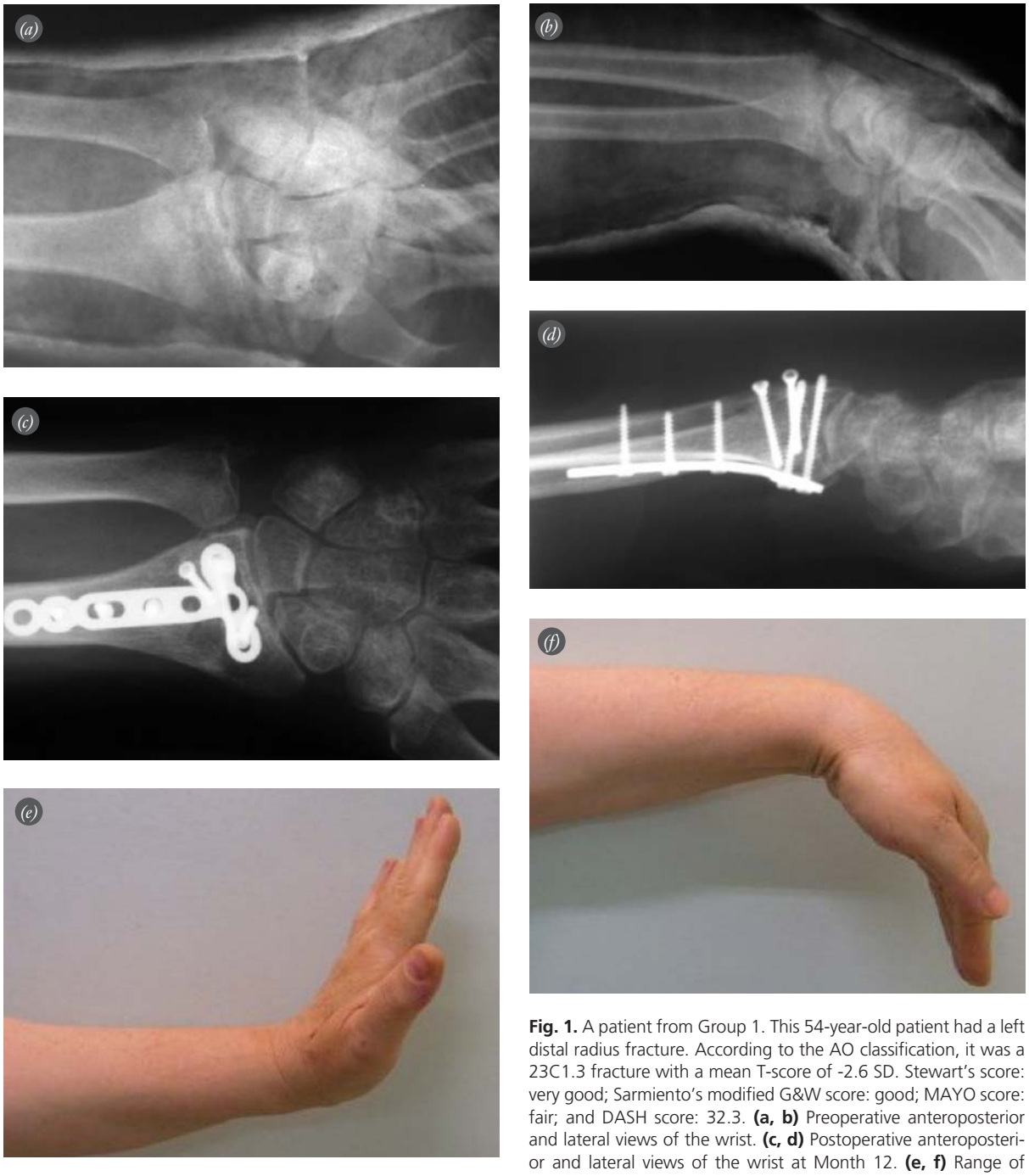

Fig. 1. A patient from Group 1. This 54-year-old patient had a left distal radius fracture. According to the AO classification, it was a 23C1.3 fracture with a mean T-score of -2.6 SD. Stewart's score: very good; Sarmiento's modified G&W score: good; MAYO score: fair; and DASH score: 32.3. **(a, b)** Preoperative anteroposterior and lateral views of the wrist. **(c, d)** Postoperative anteroposterior and lateral views of the wrist at Month 12. **(e, f)** Range of motion at dorsal and volar flexion of the wrist at postoperative Month 12. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

Discussion

Osteoporosis is characterized by decreased bone mineral intensity and is the most common bone disease.[12,13] Distal radius fractures result from falling with the hand extended with the elbow in extension.[22] In distal radius fractures, the severity of fracture increases as bone mineral density is reduced.[16]

Factors to be considered in achieving a satisfying outcome in the treatment of distal radius fractures include appropriate restoration of radial length, radial inclination and volar angulation and correction of the intra-articular step-off.[23,24] No consensus has been reached in the literature on which criteria are critical in determining prognosis in the fracture of the distal end

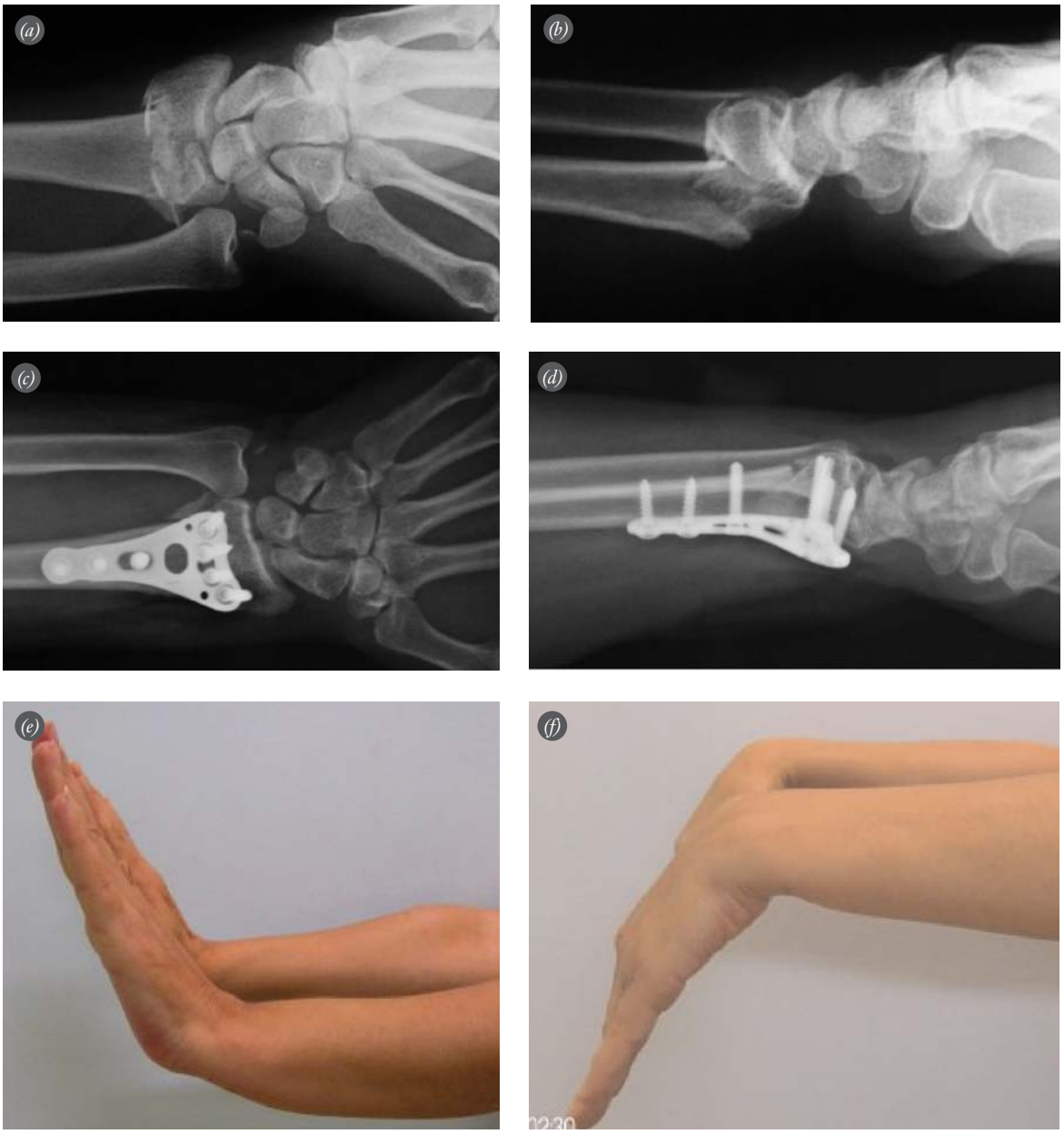

Fig. 2. A patient from Group 2. This 45-year-old patient had a left distal radius fracture. According to the AO classification, it was a 23C1.2 fracture with a mean T-score of -1.2 SD. Stewart's score: good; Sarmiento's modified G&W score: good; MAYO score: good; and DASH score: 8.2. **(a, b)** Preoperative anteroposterior and lateral views of the wrist. **(c, d)** Postoperative anteroposterior and lateral views of the wrist at Month 12. **(e, f)** Range of motion at dorsal and volar flexion of the wrist at postoperative Month 12. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

of the radius. According to Leung et al.[25] functional outcome in distal radius fractures is associated with the degree of displacement at the end of the treatment from the baseline. According to these authors, the outcome is poor with a step-off of 2 mm or more, radial shortening of 2 mm or more, dorsal tilt of 10° or more, volar tilt of 20° or more, and loss of 10° or more in radial inclination.

The AO classification,[17] which has been used since 1986, includes all types of fractures, fracture stability, treatment options and a prognostic value. Distal radius fractures are divided into 3 main groups, 9 basic and 27 subgroups. AO Type A fractures are extra-articular, AO Type B fractures are partially intra-articular and AO Type C fractures are highly-energetic and multi-fragmentary fractures. According to this classification,

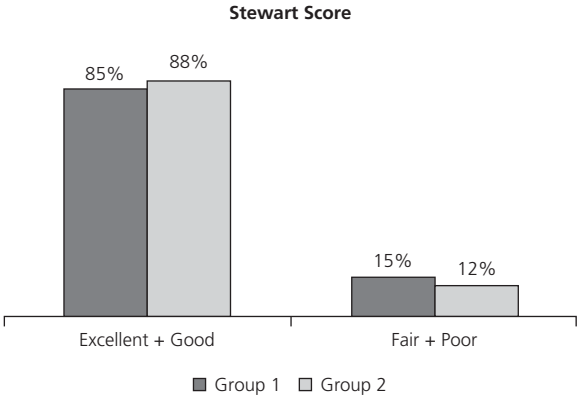

Fig. 3. Comparison of Stewart scores between Group 1 and 2 (p>0.05).

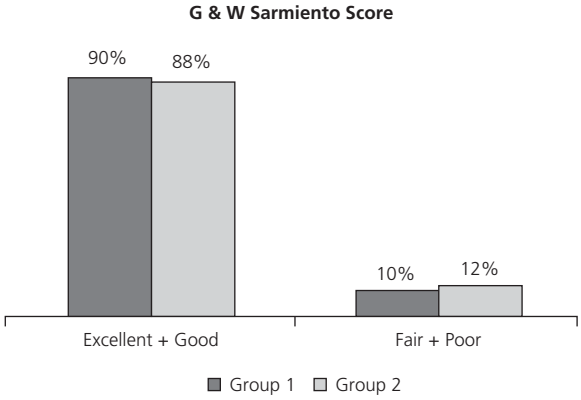

Fig. 4. Comparison of Sarmiento's modified G&W scores between Group 1 and 2 (p>0.05).

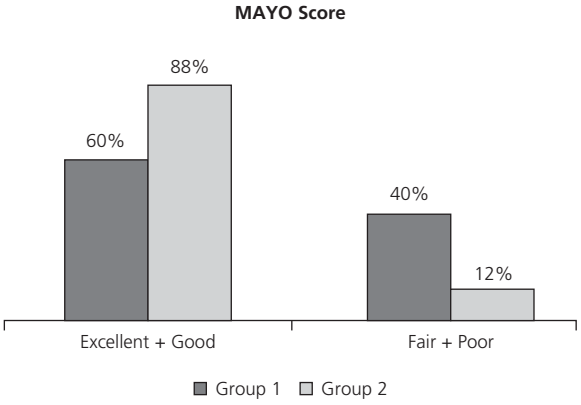

Fig. 5. Comparison of MAYO scores between Group 1 and 2 (p<0.05).

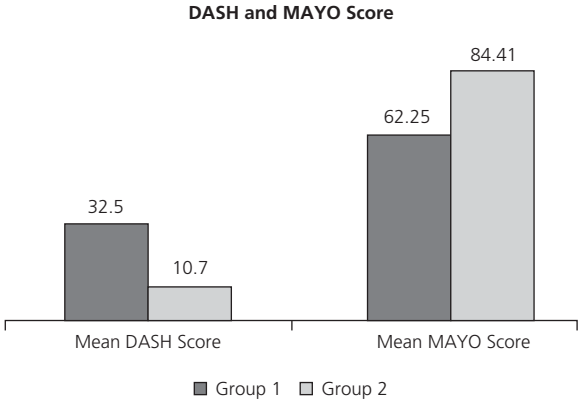

Fig. 6. Distribution of DASH and MAYO scores per patient (p<0.05 and p<0.05).

there were two 23A3.3, ten 23B1.2, eight 23B3.3, seven 23C1.2 and ten 23C1.3 fractures in our study.

All patients underwent anatomic reduction and stable fixation using volar locking plate osteosynthesis. Clayton et al.[16] found an early instability rate of 43%, late carpal malalignment of 39%, and malunion of 66% with conservative treatment of osteoporotic distal radius fractures. They concluded that lower bone mineral density was negatively associated with healing of the distal radius fractures. In a review of the literature, Gehrmann et al. reviewed 41 articles, including at least 10 patients, and concluded that volar locking plate osteosynthesis is suitable for elderly patients due to its contribution to the process of union.[26] In a meta-analysis, Goldhahn et al. found that outcomes of plate osteosynthesis in osteoporotic patients, particularly data on frequency of malalignment, have not been sufficiently studied in clinical studies.[27] However, Orbay and Fernandez believe that volar locking plate osteosynthesis is superior to other surgical techniques in the treatment of unstable distal radius fracture due to low complication rates and early return to function.[28] Mudgal and Jupiter also believe that anatomic and stable fixation with plating in selected osteoporotic patients is more advantageous in terms of morbidity, compared to other surgical techniques.[29] Therefore, we believe that anatomic and stable fixation of fractures in patients with lower bone mineral density and a shortening of the period of immobilization will prevent further deterioration of the bone quality and reduce morbidity.

Wigderowitz et al. suggested routine measurement of bone mineral density in female patients with a fracture of the distal end of the radius, particularly if they are under 66 years of age.[12] Eren et al. proposed that bone mineral density should be measured in all postmenopausal women to predict occurrence of fractures.[8] Osteoporosis-related diagnostic and treatment activities may prevent fractures and the morbidity and mortality problems that may develop secondary to

them.[30] In the present study, 37 patients with a mean age of 47.6 (range: 27 to 65) years received bone mineral density testing at the femoral neck and lumbar spine (L1-L4) using the DEXA method following the surgery. Based on the results, patients with a T score of -2.5 SD and below were diagnosed with osteoporosis. Group 1 included 20 patients with osteoporosis while Group 2 consisted of 17 patients without osteoporosis.

While Earnshaw et al.,[13] Kamano et al.[21] and Sakai et al.[31] suggest a correlation between osteoporosis and fracture of the distal end of the radius, Härmä and Karjalainen,[14] Hastings and Leibovic[32] and Hesp et al.[10] reported the opposite. Mallmin and Ljunghall proposed that patients with distal radius fracture should be considered for prophylactic treatment against osteoporosis.[33] Oyen et al. suggested that patients with distal radius fracture aged 50 years and over should be referred to bone densitometry before starting treatment of osteoporosis.[34] In the present study, patients who were found to be osteoporotic (Group 1) based on the densitometric measurements received a medical treatment protocol including calcium, vitamin D and bisphosphonate.

We used radiological evaluation criteria described by Stewart et al.[18] in 1985 to evaluate the functional results at postoperative Month 12. Difference of loss in dorsal angulation, radial shortening and radial angulation compared to normal values were objectively measured directly on the radiograph of the patient and scored between 0 and 3, depending on the level of deterioration. Based on this, "fair and poor" outcomes were found in 15% of Group 1 and 12% of Group 2 patients (Fig. 3). Patients were also assessed according to the Sarmiento's modification of the Gartland and Werley score which provides objective evaluation based on detection of radial deviation in the wrist and prominence of ulnar styloid by inspection, measurement of range of motion, determination of arthritic changes directly on the radiograph and consideration of resulting nerve lesions, as well as subjective evaluation of patient satisfaction.[19] Group 1 and Group 2 had 90% and 88% "excellent and good" outcomes, respectively (Fig. 4). As no statistically significant difference was found in both evaluations between the two groups ($p>0.05$ and $p>0.05$), we concluded that there was no problem with the anatomic restoration of the wrist.

To evaluate postoperative activities of daily living we used the DASH scoring system,[20] a subjective tool consisting of self-reported questions (Fig. 6). We also used the MAYO Clinic modified wrist-scoring system[21] which is a questionnaire to subjectively evaluate pain and satisfaction of patients and objectively evaluate range of motion of the joint and grip strength (Fig. 5). A statistically significant difference was found between the two groups in both evaluations ($p<0.05$ and $p<0.05$). This result shows that activities of daily living in osteoporotic group were more affected than in the other group.

In conclusion, although satisfactory radiological outcomes are obtained in osteoporotic patients with distal radius fracture, activities of daily living are significantly restricted and osteoporosis has an adverse impact on functional outcomes. Evaluation of osteoporosis in patients with distal radius fracture should be considered an opportunity for early diagnosis and treatment of osteoporosis as a public health concern and for preventing its complications.

Conflicts of Interest: No conflicts declared.

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