The functional and radiographic outcomes following distal radius fracture treatment in a cast for 4 and 6 weeks in the elderly: A randomized trial

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Abstract

Background. The optimal duration of cast immobilization following distal radius fractures (DRFs) in elderly patients has not been established.

Objectives. To assess the functional and radiological parameters following DRF treatment in elderly patients using 2 different periods of cast immobilization.

Materials and methods. We assessed 50 patients (33 women and 17 men). The mean age at the beginning of treatment was 71 years. The mean duration of follow-up was 1 year and 3 months. One subgroup (n = 26) included patients treated with a cast for 4 weeks, whereas the other subgroup (n = 24) included patients treated with a cast for 6 weeks. The following measures were assessed: union rate, radial inclination, volar tilt, radial height, Visual Analogue Scale (VAS) pain score, Mayo Wrist Score, and VAS activity score.

Results. The mean volar tilt was 9.13° in the group treated with a cast for 4 weeks and 3.29° in the group treated with a cast for 6 weeks (p = 0.043). There were no differences between the groups in terms of any other functional or radiological parameters.

Conclusions. The VAS pain score, Mayo Wrist Score and VAS activity score were similar between the 2 study groups. The greatest volar tilt angle was observed after 6 weeks of cast immobilization. The study groups showed no significant differences in terms of radial inclination, union rate, radial height, or bone union. A period of 4 weeks of cast treatment was sufficient for elderly patients with DRFs.

Key words: distal radius fracture, functional, radiographic, elderly

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Background

Distal radius fractures (DRFs) are among the top 3 fracture locations, which makes these fractures a considerable social problem and a major healthcare burden.[1–12] A closed reduction and immobilization using a forearm cast is indicated in simple fractures, in poor soft tissue condition around osteoporotic bone, and in less demanding patients, such as the elderly.[11–15] A closed reduction and immobilization including a forearm cast is the preferred method of treatment for DRFs in the elderly,[13] particularly since it is associated with good functional and clinical outcomes.[11]

There is no gold standard in terms of maintenance time for a plaster cast in patients with DRF.[9,13–17] Some studies recommend cast immobilization for 4 weeks,[9,13] some prefer a 5-week cast immobilization,[13,14,17] whereas others advocate a 6-week treatment.[9,15] To date, no studies have assessed the radiological and functional impact of cast immobilization time in DRF treatment in the elderly. Toon et al. noted a mean pain severity of 1.1 using the Visual Analogue Scale (VAS) after closed reduction and immobilization in a forearm cast, and 1.8 after open reduction and plate stabilization.[9] Kilic et al. and Yin et al. observed 100% bone union after closed reduction and immobilization in a forearm cast, without assessing the effects of the immobilization period on achieving bone union.[13,18] The studies which have analyzed nonsurgical treatment for DRF likewise did not consider the effects of the immobilization period on radiographic outcomes.[9,13,15]

A comparison of DRF treatment outcomes following cast immobilization for different periods of time may help in selecting the optimal duration of cast immobilization. The DRF treatment outcomes can be adequately compared via radiographic and functional assessment. Some studies have reported a correlation between good radiological and clinical outcomes.[5,19,20] A long period of immobilization in a cast may adversely affect the range of motion and hand function, and reduce muscle strength in patients with DRF.[16,17,21,22] These factors suggest the need for limiting the period of immobilization in elderly patients with DRFs. However, shortening the immobilization time may increase the frequency of bone fragment instability, bone nonunion and persistent pain. We hypothesized that the period of cast immobilization would affect radiographic and functional outcomes in the elderly patients treated for DRF.

The aim of our randomized trial was to perform functional and radiological evaluation of elderly patients after DRF treatment, depending on the period of cast immobilization.

Materials and methods

Our study was a prospective evaluation of patients with DRF treated between June 2020 and November 2020. Within this period, 117 patients with DRF were treated in our hospital. The following inclusion criteria were used: DRF with closed reduction and immobilization in a forearm cast; follow-up of at least 12 months after treatment completion; availability of radiological documentation; complete data on VAS-rated pain severity; VAS activity scores and Mayo Wrist Scores; age >65 years. The exclusion criteria included: bilateral upper limb injury; a multifragment fracture; surgery treatment; lack of complete medical and radiological documentation; age <65 years; incomplete medical and radiographic data; incomplete data on VAS pain scores, VAS activity scores or Mayo Wrist Scores. We assessed only the patients who initially qualified for conservative treatment, i.e., patients with simple fractures. In both groups, there were no patients with multi-fragment fractures, open fractures, intra-articular fractures, or initially unstable fractures eligible for surgery. The patients were informed about the voluntary nature of the study. All study protocols were approved by the Bioethics Committee at the Lower Silesian Medical Chamber in Wrocław, Poland (protocol No. 2/PNDR/2020, date of approval: June 10, 2020). Informed consent was obtained from all subjects. The study was conducted in accordance with the guidelines of the Declaration of Helsinki.

A total of 50 elderly patients (17 men and 33 women) met the study inclusion criteria. The mean age of the evaluated patients at the time of injury was 71 years (range: 65–86 years). The mean body mass index (BMI) was 27.4 kg/m^2 (range: 21.5–35.3 kg/m^2). The mean follow-up period was 1 year and 3 months (range: 12–18 months). The patients who were diagnosed with DRF and provided informed consent were randomized. The randomization was carried out using numbered sealed envelopes, with patients allocated to one of the 2 subgroups, each with a different duration of cast immobilization. The 1st group (n = 26) consisted of patients who were to undergo cast treatment for 4 weeks and the 2nd group (n = 24) of patients slated for a 6-week treatment. The patients from both study groups underwent a closed reduction of their fracture in an emergency room and had their injured limb immobilized in a short arm cast. The first control X-rays were performed in the emergency department immediately after reduction and cast immobilization. The fracture was reduced with the arm stabilized by the assist, using traction, volar flexion and radialization of the hand and wrist. The limb was immobilized in a short arm cast in the volar flexion and wrist radialization. None of the patients developed a secondary displacement of reduced bone fragments which would require surgery.

All patients were periodically assessed radiographically and clinically during outpatient clinic visits. The casts were removed after 4 or 6 weeks, depending on the group. After cast removal, all patients were introduced to the identical exercise protocols for their hand and wrist. For 4–6 weeks, the patients were advised to use the affected hand sparingly. Based on clinical and radiological assessments, the use of the affected upper limb was gradually increased.

The following radiographic and functional parameters were evaluated: 1) union rate, 2) radial inclination, 3) volar tilt, 4) radial height, 5) VAS pain score, 6) Mayo Wrist Score, and 7) VAS activity score.

Bone union was assessed clinically and radiographically. Radiologically, bone union was found in the presence of 3 of the 4 cortical layers of bone, or with trabecular transition between fragments of the fractured bone on X-rays in 2 projections.[7,23] The clinical union was found in the absence of pathological mobility, pain and deformation during strong movement attempts around the wrist. The nonunion was found when the criteria of union were not met more than 6 months after the injury. The radial inclination was measured in anteroposterior radiographs of the wrist, and was defined as the angle between the line parallel to the distal radial articular surface and the line perpendicular to the long axis of the radius. The normal range for radial inclination of 16–29° was adopted based on previous studies.[6,7,15,24] Any deviation from the normal radial inclination was measured and presented in degrees.

The volar tilt was measured on lateral radiographs of the wrist, and was defined as the angle between the distal radial articular surface and the line perpendicular to the long axis of the radius. The normal range of volar tilt between 15° and 0° was adopted based on prior studies.[6,7,15] Any deviation from the normal range was measured and presented in degrees. Radial height, which was measured in postoperative anteroposterior radiographs, was defined as the distance between 2 parallel lines, both perpendicular to the long axis of the radius, with one of the lines passing through the tip of the radial styloid process, and the other through the distal ulnar articular surface. A normal radial height is 10–13 mm; these values, within a 5-mm range, were based on prior published studies.[6,15] Any deviation from normal values was presented in millimeters.

The pain severity was assessed using the VAS.[7,9] The Mayo Wrist Score was measured on a scale ranging from 0 to 100 points. The scores represent pain on active flexion/extension compared to the contralateral wrist, and indicate the possibility of resuming work and the relative muscle strength.[7,9,25] Subjective physical activity was assessed by patients on a scale ranging from 0 to 10.[26,27] All patients were assessed clinically and radiographically at follow-up for more than 1 year after the end of treatment. The groups with immobilization in plaster cast for 4 weeks and for 6 weeks were compared. Statistical analyses were carried out using STATISTICA v. 13.1 (StatSoft Inc., Tulsa, USA). The Student's t-test was used to compare quantitative variables between groups. The Bartlett's test, Cochran's test and Hartley's test were used to evaluate homogeneity of variance between the groups. The Shapiro–Wilk test was used to assess the normality of the distributions (Table 1). A critical value of $p \leq 0.05$ was used throughout this study.

Results

The age of the patients in the 2 evaluation groups was comparable ($p = 0.562$). There was no nonunion in any of the evaluated patients from both study groups (Table 1).

The radial inclination did not differ statistically between the study groups with the 2 different cast immobilization periods ($p = 0.619$) (Table 1). Better outcomes were observed after 6-week cast immobilization, with the mean radial inclination 0.25° beyond the adopted normal range. Somewhat worse outcomes were observed after a 4-week immobilization period, with the mean radial inclination 0.55° beyond the adopted normal range (Table 1). The volar tilt values closer to normal were observed in the group treated for 6 weeks (with the mean value of 3.29° beyond the adopted normal range). Considerably worse results were achieved after 4 weeks of immobilization (9.13°). The difference was statistically significant ($p = 0.043$) (Fig. 1, Table 1).

The group that achieved better post-treatment radial height values was the group treated for 4 weeks (with the final radial height differing from the normal by a mean of 1.9 mm). Somewhat worse radial height values were observed after

Table 1. Detailed results of the functional and radiological evaluation of individual subgroups

Analyzed variable (mean ±SD)	4-week group (n = 26)	6-week group (n = 24)	Shapiro–Wilk test – p-value		Bartlett's test, Cochran's test and Hartley's test p-value	Student's test p-value
			4-week group	6-week group		
Age of patients [years]	71.34 ±4.99	72.20 ±5.46	0.781	0.869	0.241	0.563
Radial height [mm]	0.55 ±2.84	0.25 ±1.03	0.054	0.050	0.672	0.619
Volar tilt [°]	9.13 ±7.12	3.29 ±5.11	0.074	0.094	0.522	0.043
Union	1 ±0	1 ±0	–	–	–	–
Radial height [°]	1.9 ±1.62	2.45 ±2.47	0.900	0.214	0.367	0.351
VAS pain score	2.53 ±3.06	3.58 ±2.56	0.087	0.064	0.472	0.199
VAS activity score	7.61 ±1.83	7.58 ±2.3	0.052	0.082	0.587	0.957
Mayo Wrist Score	58.46 ±21.24	61.87 ±22.97	0.300	0.147	0.687	0.588

SD – standard deviation; VAS – Visual Analogue Scale.

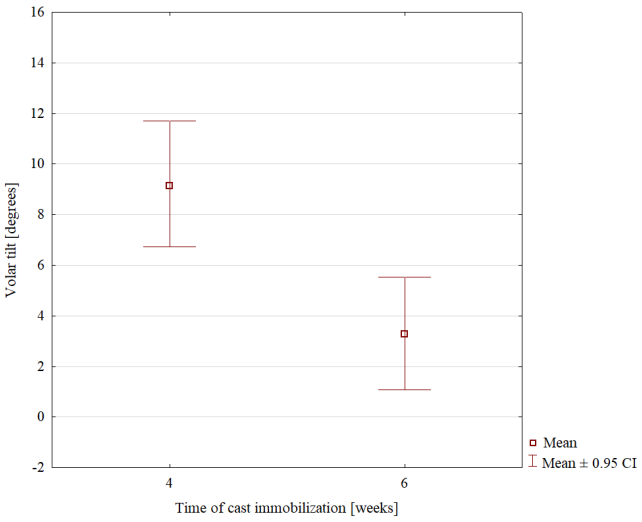

Fig. 1. Volar tilt in subgroups

CI – confidence interval.

6 weeks of cast immobilization (a mean of 2.45 mm beyond the normal value; Table 1). However, these differences were not significant (p = 0.351). The patient-reported pain severity was lower in the 4-week group (VAS score of 2.53), with the moderately higher mean VAS pain score of 3.58 in the 6-week group. These differences were not significant (p = 0.199) (Table 1). The mean Mayo Wrist Score was 58.46 in the subgroup treated for 4 weeks and 61.87 in the subgroup treated for 6 weeks (Table 1). This difference was not statistically significant (p = 0.588). There were no statistical differences in the VAS activity score between the group with 4 weeks of immobilization (7.61) and the group with 6 weeks of immobilization (7.58) (p = 0.957; Table 1).

Discussion

Our study used functional and radiographic measures to assess whether elderly with DRF who undergo cast immobilization can complete their treatment earlier (after 4 weeks) and resume their normal activities without having to have their limb immobilized in a cast for 6 weeks. There have been no studies evaluating functional and radiographic parameters of elderly patients following DRF to determine which cast immobilization period (4 or 6 weeks) produces better outcomes. The outcomes achieved in patients whose fracture was immobilized for 6 weeks were significantly better only in terms of volar tilt. We observed no significant differences between the study groups in any of the other assessed parameters. Thus, our research hypothesis was only partially confirmed.

Distal radius fractures are among the top 3 fracture locations, which makes such fractures a considerable social problem and healthcare burden.[1–12] Distal radius fractures is often treated conservatively.[11,13–15] There is no gold standard regarding the maintenance time of a plaster cast for DRF.[9,13–17] Some studies propose a 4-week immobilization period,[9,13] some propose a 5-week period,[13,14,17] while others advocate 6 weeks of cast immobilization.[9,15] A long maintenance time of a plaster cast may have a negative effect on the range of motion and hand function, and reduce muscle strength in patients with DRF.[16,17,21,22] These factors suggest that a shorter maintenance time of a plaster cast following DRFs would be more beneficial in elderly patients. A shorter maintenance time of a plaster cast in patients who have achieved bone union may allow for earlier exercises, limb rehabilitation and the return of limb function.[15–17,21] However, it should be noted that reducing the cast immobilization period in the elderly with osteoporosis may contribute to more complications in the form of bone fragment instability, nonunion and persistent pain.

The mean VAS pain score after treatment for DRFs was 1.1–1.8, which is comparable to the findings of prior studies.[7,9,28] No studies have compared the VAS pain scores following DRF treatment with a cast over time. In our study, we observed no differences in VAS pain scores between the 4-week group and the 6-week group. Our results were comparable to those of other researchers.[7,9,28] The mean Mayo Wrist Score was 82.4–85.3 in DRF patients stabilized with a plate.[7,25] Other masurements we obtained were similar, but lower in comparison to those reported by other authors.[7,9,25] The mean VAS activity scores in patients who underwent osteotomy with an Ilizarov fixator,[26] those with ankle joint arthrodesis with an Ilizarov fixator, and those with internal fixation were 5.98, 6.85 and 5.35, respectively.[27] In our study, VAS activity scores did not differ between the 4-week group and the 6-week group. These scores were somewhat better than those reported in prior studies.[26,27] Bone union was found in all patients after DRF treatment with plate stabilization or immobilization in plaster cast.[13,18,29] In our study, bone union was achieved in all patients from both study groups; this outcome was similar to those reported in prior studies.[13,18,29]

Katayama et al. reported a correlation between abnormal radial inclination and the development of arthritis; the mean radial inclination in the evaluated study group was 24.2°.[7] Radial inclination angles closer to normal were observed by Toon et al. in a group of patients with cast immobilization (16.9°).[9] Lameijer et al. observed a post-treatment radial inclination of 25.5° in patients without osteoporosis following DRFs.[24] Kilic et al. observed a radial inclination of 17 ±4.6° in patients after plaster cast immobilization.[13] Zengin et al. reported post-treatment radial inclination angles that were closer to normal in a group with a volar plate stabilization (mean radial inclination of 21.5°) than in patients with a cast immobilization (16.6°).[15] Arora et al. found a radial inclination of 19.2 ±6.5° in the cast immobilization group.[14] In our study, both groups achieved radial inclination angles close to normal, with no significant differences between the groups. Our radial inclination angles values were similar to those reported in earlier studies.[7,9,13–15,24]

Katayama et al. observed a correlation between abnormal volar tilt angles and the development of arthritis; the mean volar tilt angle in that study group was 6.4°.[7] Toon et al. reported better mean volar tilt angles in a group of patients treated with plate fixation (5.6°) in comparison to those treated with plaster cast immobilization (0.1°).[9] Kilic et al. observed a volar tilt of 5.6 ±5.4° in a cast group.[13] Arora et al. observed a volar tilt of –24.4 ±–12° in a group with cast immobilization.[14] Zyluk et al. observed volar tilt angles closer to normal ones in a group with volar plate fixation and K-wire stabilization.[19] The mean post-treatment volar tilt angles reported by Zengin et al. were within the adopted normal range in patients treated with volar plate fixation (6.9°) but fell outside of the normal range (–1°) in patients treated with cast immobilization.[15] In our study, volar tilt values closer to normal were observed in the 6-week group, whereas values different from the normal ones were noticed in the 4-week group. The volar tilt angles were significantly better in the group with 6 weeks of cast immobilization. The volar tilt angle values in our study were similar to those of other studies.[7,9,13–15,19]

The mean radial height value in DRF patients treated with cast fixation was 3.9–9.0 mm, depending on the group.[9,13–15] In our study, both groups achieved radial height values close to normal. The study subgroups did not differ significantly in terms of radial height and these values in our study were comparable to those of other studies.[9,13–15] Some studies have found a correlation between good radiological and clinical outcomes after DRF treatment.[5,19,20] In contrast, other studies reported good treatment outcomes even with poor radiographic outcomes.[9,14,15] In our study, we achieved good radiographic and functional outcomes in both study groups, likely since patients experienced only mild pain following their treatment. Apart from volar tilt angle values in radiographic assessments, we have observed no differences between the study groups in either radiographic or functional parameters. These outcomes indicate the possibility of regaining full limb function by the elderly treated for DRF with 4 weeks of cast immobilization.

Our study showed that a period of 4 weeks was sufficient to achieve complete fracture remodeling and bone union in all patients. The similar radiographic and functional outcomes achieved in both evaluated groups encourage us to recommend a 4-week period of fracture immobilization. This duration of cast immobilization will help introduce earlier rehabilitation, earlier return to normal use of the injured arm and a more rapid return to normal daily functioning in older patients with DRF. One limitation of our study was the relatively small sample size. However, other studies have also used a similar or smaller group.[7,9,13,25] The strengths of our study are patient randomization, the same rehabilitation protocol for all patients and the same examination protocol carried out by one orthopedist. We aim to perform a follow-up study in a larger group of patients.

Conclusions

The study groups did not differ in terms of VAS pain scores, Mayo Wrist Scores or VAS activity scores. The highest volar tilt angle value was observed after 6 weeks of cast immobilization. All patients from both groups achieved bone union. The study groups showed no significant differences in terms of radial inclination, union rate or radial height. Both groups achieved good functional and radiographic outcomes. In summary, we found that cast immobilization for a period of 4 weeks is sufficient for DRF treatment in the elderly.

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