Are the clinical results of locking plate fixation for distal radius fractures inferior in patients over 80 years of age? A multicentre (TRON group) study

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Abstract

Introduction

With the aging of the population, the proportion of distal radius fracture patients who are >80 years of age is increasing. In this study, we compared the postoperative clinical and radiographic outcomes between super-elderly patients (age: ≥80 years) and middle-elderly (age: 65–79 years) who were treated with volar locking plate (VLP) fixation for distal radius fractures.

Patients and Methods

Patients of >65 years of age with distal radius fractures treated by VLP fixation between 2015 and 2019, and who were followed for at least 6 months after surgery were included in our database (named TRON). Patients with open fractures, multiple-trauma, or who received fixation with implants other than a VLP were excluded. We evaluated postoperative complications, Mayo wrist score (MWS), and radiographic outcomes.

Results

We identified 589 patients in this study; 452 were 65–79 years of age (Group A) and 137 were ≥80 years of age (Group B). After propensity score matching, we evaluated 309 patients in Group A and 103 patients in Group B. The mean follow-up period was 10.7±4.6 months. Twenty-eight patients (9.1%) in Group A and 5 patients in Group B (4.9%) experienced post-operative complications (non-significant: p=0.212). The postoperative MWS at 1, 3, and 6

months, respectively, was 65.4±11.7, 75.2±11.0, and 79.6±10.5 in Group A and 67.1±9.61, 75.7±10.7, and 80.6±9.7 in Group B (non-significant: p=0.418, 0.893, 0.452, respectively). The differences in volar tilt, radial inclination, ulnar variance between the postoperative and last follow-up radiographs did not differ between the two groups to a statistically significant extent (p=0.053, 0.437, 0.529, respectively).

Conclusion

Our study showed that the clinical and radiographic outcomes of distal radius fractures treated with VLP in super-elderly patients were comparable to those in middle-elderly patients.

Statements and Declarations

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Author contributions

SS: Data collection and assessment, Study design, Writing the paper. YT: Manuscript preparation, Study and Conception design. KT: Manuscript preparation, Study design. YK: Data collection and assessment, Manuscript preparation. RS: Data collection, Manuscript preparation. HO: Manuscript preparation. HK Manuscript preparation, SI: Conception design, Guarantor

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Conflict of interest statement

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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Keywords

Super-elderly; distal radial fracture; locking plate; multicentre

Introduction

The population age distribution is changing globally, with an increasing proportion of older people. The UN estimates that by 2050, adults of ≥80 years of age are expected to make up 4.5% of the world's population. [1] As the elderly population increases, the incidence of osteoporosis-based fragility fractures, including vertebral compression fractures, hip fractures, and distal radial fractures, is increasing. The previous registry study in Sweden reported that approximately 17% of all distal radius fractures occur in the super-elderly (age: ≥80 years).[2] A previous U.S. population database study indicated that the proportion of super-elderly patients with distal radius fractures was approximately 22% for all ages.[3]

In Japan, the percentage of elderly individuals who require long-term care is approximately 30% for those of >75 years of age and approximately 5% for those of 65–75 of age; thus, the older the age, the higher the percentage of individuals who require long-term care.[4] Many super-elderly individuals require assistive instruments to walk, which increases the load on the upper limbs in daily life. Upper limb stability may have a significant impact on the activities of daily living in the super-elderly.

The volar locking plate (VLP) is widely used for distal radial fractures and is known to be able to obtain sufficient fixation in patients with osteoporosis. Thus, open reduction and internal fixation with a VLP has been increasingly performed for distal radius fractures in the elderly, and previous studies have reported good clinical outcomes.[5] However, the effectiveness of surgical treatment with VLP for the super-elderly remains unclear. A previous study demonstrated that bone mineral density decreases with increasing age.[6] A case-series showed that VLP fixation for elderly patients of >70 years of age and showed good results with an MWS of >90 (excellent) in only 65% of patients. [7] Therefore, there is a concern that the clinical and radiographic outcomes of surgical treatment in super-elderly patients may be inferior to those of middle-elderly patients (age: 65–74 years).

We aimed to compare the clinical and radiographic outcomes in the super-elderly to that in the middle-elderly patients who underwent VLP for distal radius fractures. We hypothesized that both of them would be worse in super-elderly individuals in comparison to middle-elderly individuals.

Patients and Methods

Subjects

This multicentre retrospective study used data obtained from database, named TRON constructed from cases managed at our university and affiliated hospitals since 2014. The study was conducted in accordance with the ethical standards of the responsible committee and the ethical principles of the 1975 Declaration of Helsinki. This multicentre retrospective study was approved by the Ethics Committee of each participating hospital. (Reference number: 2020-0564) In addition, the patients gave their informed consent, after being informed that they had been registered, the purpose of the registration, and the procedure to remove themselves from the registry.

The present study targeted all surgical distal radius fractures in patients aged 65 years and above registered in the TRON database between 2015 and 2019. We excluded patients who had open fracture, multiple-trauma, or who were treated with implants other than the VLP. Then, we divided patients into two groups of age: 65-79 years (Group A) and 80 years or older (Group B), and adjusted the background of two groups using propensity score matching (Fig.1).

We collected 1) patient baseline characteristics: age, sex, body mass index (BMI), the American Society of Anesthesiologists-Physical Status (ASA), and comorbidities, and 2) data related to injury: injury mechanism, injury side (dominant or not), and AO/OTA fracture classification.[8] High-energy trauma was defined as anything worse than a fall from a second floor or traffic accidents between pedestrians or motorcycles and automobiles, whereas low-energy trauma was defined such as a fall from a standing position.[9]

Clinical evaluation

We assessed postoperative complications, re-operations, Mayo wrist score (MWS)[10], and visual analogue scale (VAS)[11] values at 1, 3, and 6 months after surgery. Complications included the following events that occurred during the follow-up period: tendon rupture, infection, hardware failure, neurological impairment, intra-articular screw penetration, complex regional pain syndrome (CRPS).[12] Superficial or deep infection was determined according to the criteria of Horan et al.[13] The occurrence of any sensory or motor disturbance, or numbness was defined as neurological impairment.[14] Intra-articular screw penetration was suspected on a plain radiograph, and CT was performed to confirm the diagnosis. Cases involving implant removal due to the patient's request (without complications) were excluded from this study.

Radiographic evaluation

Preoperative fracture types were classified using the AO/OTA classification and divided into two fracture types: stable and unstable. We identified A3/B3/C3 as unstable types.[15] Anterior-posterior and lateral radiographs of the wrist joint were obtained at each follow-up examination. We measured volar tilt, radial inclination, and ulnar variance on each film and recorded them in either degrees or millimetres preoperatively, immediately postoperatively, and at the last follow-up examination.[16]

Statistical analysis

Categorical data were compared between the two groups using Fisher's exact test. Welch's T-test was performed for the analysis of all continuous variables. The radiographic assessments were reviewed by two orthopaedic trauma surgeons. The intraclass correlation coefficients (continuous variable) and Kappa coefficient (categorical data) for inter-observer reliability were calculated (0.67 and 0.71, respectively). The mean number of missing values for continuous variables was 30 out of 414 cases (7.2%), and the missing values were removed using the pairwise method. P values of <0.05 were considered to indicate statistical significance. All statistical analyses were performed using the EZR software program (Jichi Medical School, Tochigi, Japan).[17]

Results

A total of 589 patients were identified in this study; 452 patients were classified into Group A and 137 patients were classified into Group B. We adjusted the background of the analysed cases using propensity score matching with six covariates (sex, BMI, DM, injury side, ASA, fracture type), finally we evaluated 309 patients in Group A and 103 patients in Group B.

The patients' demographic data are presented in Table 1. The mean follow-up period was 10.7±4.6 months (range: 6-54 months). The mean age was 72.1±4.4 years in Group A and 83.6±2.9 years in Group B. There were significantly more patients in Group B who lived in a nursing home in comparison to Group A (Group A, 0.6%; Group B, 7.8%; p= 0.001). The other patient background factors of the two groups did not differ to a statistically significant extent.

The total number of postoperative complications was 28 in Group A (9.1%) and 5 in Group B (4.9%) (non-significant: p=0.212). Among the postoperative complications, 3 patients experienced implant failure (Group A, n=2 [0.6%]; Group B, n=1 [1.0%]). All of these patients underwent revision with a long VLP. There were 5 patients with CRPS, 3 of whom recovered with analgesics and exercise therapy; 2 patients experienced persistent pain. Infection occurred in 2 patients (superficial infection, n=1; deep infection, n=1). Both the cases healed with intravenous antibiotics alone and bone union was achieved. Fourteen patients experienced neurological impairment. One patient in Group B had paraesthesia in the ulnar nerve region and one patient in Group A had temporary mild sensory paralysis in the radial nerve region, which resolved spontaneously with observation alone. The other 12 patients had numbness in the median nerve region. Among these, 5 patients experienced spontaneous relief and 3 patients were cured by implant removal alone; 2 patients who were not cured by implant removal alone underwent carpal tunnel release. In 1 patient in Group A, the extensor digitorum communis tendon ruptured after bone union; this was treated by tendon transfer at the same time as implant removal. Ten patients (3.2%) in Group A had intra-articular screw penetration. Since all cases were asymptomatic, no revision surgery was performed (Table 2).

Figure 2 shows a box plot of the postoperative MWS values. The mean MWS values in Groups A and B, respectively, were 65.4±11.7 and 67.1±9.61 at 1 month (non-significant: p=0.418); 75.2±11.0 and 75.7±10.7 at 3 months (non-significant: p=0.893), and 79.6±10.5 and 80.6±9.7 at 6 months (non-significant: p=0.452).

Postoperative radiographic evaluations showed that the difference of VT between the last follow-up and the immediate post-operative value was 2.2±2.9 in Group A and -1.1±4.8 in Group B (non-significant: p=0.053), that of RI was 1.7±2.4 in Group A and 0.2±3.8 in Group B (non-significant: p=0.437), and that of UV was 1.5±2.2 in Group A and 1.4±1.6 in Group B (non-significant: p=0.529). (Table 3)

Discussion

This study showed that, contrary to our hypothesis, there were no significant differences in the bone union rate or complication rate between patients in the middle-elderly and super-elderly groups. Based on these results, it was considered that adequate fixation was achieved using the VLP, even super-elderly patients with osteoporotic bone. In a biomechanical study that analysed patients treated with VLP fixation, Sokol et al.[18] showed that although the stiffness of fixation of osteoporotic bone was inferior to that of non-osteoporotic bone, axial pressure of up to 400 N could be tolerated. Turner et al.[19] indicated that the axial load during sit-to-stand was 20–30% of the body weight (approximately 200 N when the body weight was 70 kg). In addition, Anglin et al.[20] reported that the axial stress on the wrist joint during cane walking was approximately 18% of the body weight, and that when lifting a 5 kg box was approximately 3% of the body weight. These results suggested that VLP fixation of osteoporotic bone could provide sufficient stability for daily activities in super-elderly patients.

Contrary to our hypothesis, in the present study, the MWS values of the super-elderly patients were comparable to those of the middle elderly patients. Piuzzi et al. [7] performed VLP fixation for elderly patients of >70 years of age and showed good results with an MWS of >90 (excellent) in 65% of patients and >80 (good) in 23% of the patients at the last follow-up examination. Zeckey et al.[21] also reported that the mean postoperative MWS in patients of >70 years of age was 70 at 3 months and 80 at 6 months. On the other hand, Ali Fazal et al.[22] compared the MWS values of elderly (>55 year of age) and younger (<55 years of age) patients who received VLP fixation for distal radial fractures, and found no significant difference between the two groups, with a mean value of >80 in both groups. These results were almost equivalent to the MSW values in our study. Bartl et al.[23] performed a randomized control trial (RCT) in elderly patients, comparing a surgical group (treated with VLP fixation) with a conservatively treated group, and showed that the surgical group had a better range of wrist motion at 3 months postoperatively. These results suggested that VLP fixation could achieve results in super-elderly patients that were comparable to those in younger patients.

The present study was associated with some limitations. First, this study was retrospective in nature, which could have led to selection bias, and may have increased the chance of a type 2 error. In addition, cases that were expected to have worse results may have been excluded, and the influence of confounding factors was larger. Therefore, in this study, we adjusted the background of the patients using propensity score matching to approximate a prospective study. However, because older patients would be likely to receive the conservative therapy more actively, a comparative study including a conservative therapy group may be necessary. Secondly, there was no comparison between VLP and other treatments, including conservative treatment. Saving et al.[24] reported, based on an RCT, that elderly patients who received VLP fixation for distal radius fractures had better functional assessment results at 12 months in comparison to those were treated by non-surgical methods. On the other hand, Arora et al.[25] reported, based on an RCT, that there was no significant difference in the functional outcomes between the VLP group and the non-surgical treatment group in elderly patients with distal radius fractures. Therefore, further research is needed to determine whether VLP fixation is associated with better clinical outcomes in comparison to other treatments in super-elderly patients. Third, we did not evaluate ADL scores, including the walking status (e.g., the Barthel Index). A previous study showed that the preinjury ADL status and postoperative walking status were independent risk factors for increased mortality in elderly patients with hip fractures.[26] The current study suggested that VLP provided sufficient stability for the super-elderly, and we believed that this would have a good impact on ADLs of the elderly. However, the impact of the stability achieved by VLP fixation on daily activities remains unclear. It would be useful to examine the effectiveness of surgical treatment on the elderly by assessing the EQ-5D [27] as quality of life and the Disability of the Arm, Shoulder, and Hand (DASH) [28] as patient reported outcome.

Conclusion

Our study showed that the clinical and radiographic outcomes of distal radius fractures treated with VLP in super-elderly patients were comparable to those in middle-elderly patients.

Compliance with Ethical Standards:

Funding: No funding support.

Conflict of Interest: All authors have no conflict of interest.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee (Ref no. 2020-564) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Figure legend

Figure1. Flowchart

Figure2. Box plots for Mayo Wrist Score (MWS) at 1, 3 and 6 months. Boxes show upper and lower interquartile range with the median indicated by the black horizontal line and × indicates a mean value. There is no significant difference between Group A and Group B during the follow-up period.

Table 1. Patient demographic characteristics

	Group A	Group B	p value
Number, n	309	103	
Age, years, mean±SD	72.2±4.4	83.5±2.9	
Sex, M/F, n	43/266	14/89	1
BMI, kg/m2, mean, (range)	22.4 (15.1, 35.1)	22.4 (15.5, 34.7)	0.994
ASA, n (%)			1
I	78 (25.2)	26 (25.2)	
II	220 (71.2)	73 (70.9)	
III	11 (3.6)	4 (3.9)	
DM, n (%)	49 (15.9)	18 (17.5)	0.758
Residence before injury, n (%)			0.001
Single or Couple (only)	240 (77.7)	72 (69.9)	
With children	67 (21.7)	23 (22.3)	
Nursing home	2 (0.6)	8 (7.8)	
Injury mechanism, n (%)			0.187
Low energy	283 (91.6)	99 (96.1)	
High energy	26 (8.4)	4 (3.9)	

Injury at dominant side, n (%)	152 (49.2)	52 (50.5)	0.821
AO/OTA classification, n (%)			0.906
Stable	195 (63.1)	66 (64.1)	
Unstable	114 (36.9)	37 (35.9)	
Distal ulnar fracture, n (%)	191 (61.8)	74 (71.8)	0.072
Styloid fracture	153	52	
Extra-articular fracture	25	16	
Intra-articular fracture	13	6	

SD, standard deviation; BMI, body mass index; ASA, American Society of Anesthesiologists-Physical Status; DM, diabetes mellitus

Table 2: Postoperative complications, re-operations, VAS scores

	Group A	Group B	p value
Number, n	309	103	
Complication, n (%)	28 (9.1)	5 (4.9)	0.212
Implant failure, n (%)	2(0.6)	1(1.0)	1
Infection, n (%)	2 (0.6)	0 (0.0)	1
Neurological impairment, n (%)	10(2.9)	4 (3.9)	0.756

Tendon rupture, n (%)	1 (0.3)	0 (0.0)	1
Intra-articular penetration, n (%)	10(3.2)	0	0.078
CRPS, n (%)	5(1.6)	0(0.0)	0.338
Reoperation, n (%)	6 (1.9)	3 (2.9)	0.697
Revision, n	2	1	
Implant removal, n	1	2	
Carpal tunnel release, n	2	0	
Tendon transfer, n	1	0	
VAS, mean, (range)			
1 month	2.8	2.4	0.083
3 months	1.5	1.3	0.353
6 months	0.7	0.6	0.104

CRPS, complex regional pain syndrome; VAS, visual analogue scale

Table 3: Postoperative radiographic evaluation

	Group A	Group B	p. value
Number, n	309	103	

Radial inclination, mean±SD (°)			
Post-operation	21.4±4.7	20.6±4.5	0.157
Last follow-up	22.0±6.9	20.6±5.0	0.025
Difference	1.7±2.4	0.2±3.8	0.295
Volar tilt, mean±SD (°)			
Post-operation	9.0±5.7	7.7±6.4	0.22
Last follow-up	9.3±5.7	8.8±6.5	0.828
Difference	2.2±2.9	-1.1±4.8	0.056
Ulnar variance, mean±SD (°)			
Post-operation	-0.9±3.8	-1.1±5.6	0.664
Last follow-up	1.0±3.3	1.5±4.7	0.258
Difference	1.5±2.2	1.4±1.6	0.529