Original Article | Journal of Orthopaedic Case Reports 2024 June:14(6):Page 186-190

Comparison of Conventional Incision and 10 mm Approach for Volar Locking Plates in Dorsal Displaced Distal Radius Fractures

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Learning Point of the Article:

A 10 mm approach for fixation of dorsal displaced distal radius fractures with a volar locking plate can obtain early postoperative outcomes and alignment comparable to conventional incision surgery.

Abstract

Introduction: The aim of this study was to investigate whether surgery with a 10 mm approach for volar locking plate fixation provides equivalent early post-operative outcomes to conventional incision surgery for distal radius fractures.

Materials and Methods: The subjects were divided into a conventional incision group (mean age: 59.1 years, 8 males and 23 females) and a 10 mm approach group (mean age: 59.9 years of age, 6 males and 20 females). The wrist range of motion; grip strength; visual analog scale (VAS); quick disabilities of the arm, shoulder, and hand (Q-DASH) score; and modified Mayo score were assessed at 3 months after surgery. In addition, radial inclination, ulnar variance, and volar tilt were evaluated on post-operative radiography.

Results: There was no significant difference between the groups in the wrist range of motion, grip strength, VAS, Q-DASH score, modified Mayo wrist score, and three parameters of post-operative radiography. All patients in both groups had no complications during the perioperative period.

Conclusion: We found that a 10 mm approach obtained early post-operative outcomes and alignment comparable to conventional incision surgery for patients with dorsal displaced distal radius fractures.

Keywords: Distal radius fractures, volar locking plates, conventional incision, 10 mm approach, minimally invasive plate osteosynthesis.

Introduction

Recently, minimally invasive surgery with a small incision has become widespread in surgery [1,2]. In orthopedic surgery, minimally invasive surgery has advantages such as a reduction in bleeding amount and hospital stay. Good clinical results in total hip arthroplasty and total knee arthroplasty using a minimal incision have been reported [3,4]. Furthermore, in osteosynthesis with plates, osteosynthesis using a small incision has been clinically applied, and many clinical studies have been conducted under the concept of minimally invasive plate osteosynthesis (MIPO) [5,6].

Our institution has been performing distal radius fracture fixation with a volar locking plate as MIPO for the past 10 years. Our previous study reported that volar locking plate fixation with a 10 mm approach is minimally invasive and has a cosmetic advantage; however, the procedure is more complicated than conventional incision surgery [7]. Therefore, we hypothesized that a 10 mm approach for distal radius fracture would obtain equivalent clinical outcomes to conventional surgery. In the present study, the results of early post-operative clinical

Access this article online

Website: www.jocr.co.in

DOI: https://doi.org/10.13107/jocr.2024.v14.i06.4546

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Submitted: 11/03/2024; Review: 20/04/2024; Accepted: May 2024; Published: June 2024

DOI: https://doi.org/10.13107/jocr.2024.v14.i06.4546

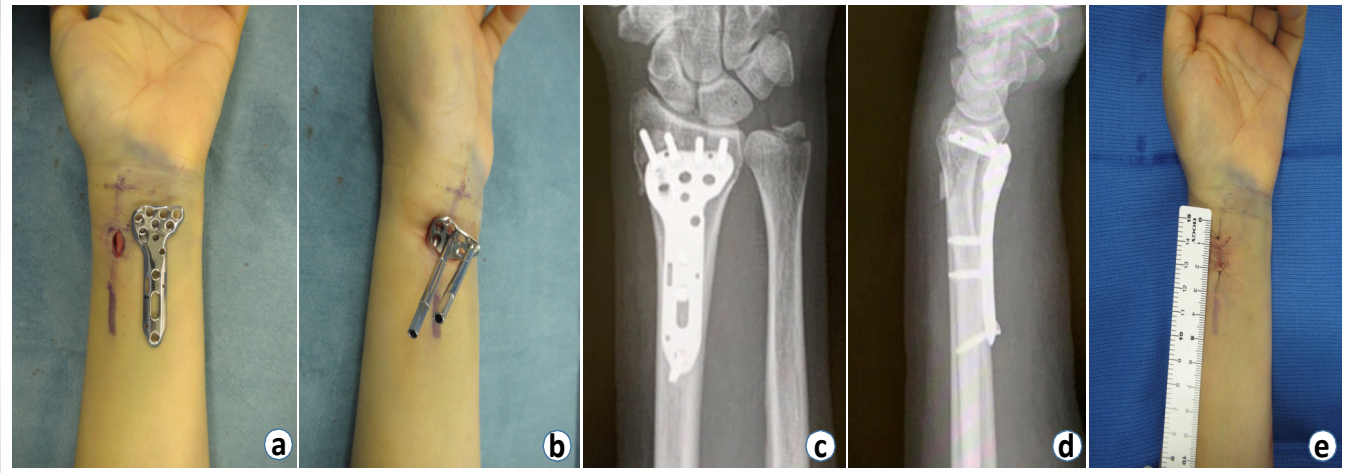

Figure 1: Surgical technique of a 10 mm approach. (a): A vertical 10 mm skin incision is made at the radial border of the flexor carpi radialis, 15 mm proximal to the radial styloid. The volar locking plate is Dual Loc V17 (MEIRA; Nagoya, Japan). (b): To manipulate the volar locking plate more easily, a threaded drill guide is attached. This technique enables the use of a 10 mm approach. (c and d): Post-operative plain radiography after volar locking plate fixation through a 10 mm approach (c: Anteroposterior view, d: Lateral view). (e): Skin closure after fixation.

outcomes were investigated and compared between conventional surgery and surgery with a 10 mm approach for distal radius fracture fixation with a volar locking plate. The occurrence of complications was investigated in both groups.

Materials and Methods

The study was approved by the Ethics Committee for Medical Research of our university (No. E22-0447), and informed consent was received from all patients.

Based on previous reports, we used A2 (extra-articular fractures) and C1 (complete articular fractures) fracture types, according to AO classification, for the 10 mm approach [7]. However, type C1 may not be suitable for fractures that involve a depressed intra-articular fragment, which is needed for the intramedullary reduction to perform osteosynthesis by this technique. Moreover, Type B fractures, or partial articular fractures, were considered contraindications.

Between January 2019 and June 2020, 57 patients underwent surgery at our hospital for a distal radius fracture. Among these, 31 patients (mean age: 59.1 [18–87] years old; eight males and 23 females; A2: eight cases, C1: 23 cases) underwent surgery with a conventional approach (C Group). On the other hand, 26 patients (mean age: 59.9 [22–88] years old; six males and 20 females; A2: 13 cases, C1: 13 cases) underwent surgery with a 10 mm approach (M Group). All patients had sustained low-energy trauma, such as collapsing to the floor. All patients underwent surgery under a brachial plexus block. A volar locking plate (Dural Loc V17; MEIRA, Nagoya, Japan) was used in all cases.

As previously described, volar locking plate fixation was performed with the Henry approach through a 10 mm incision [7]. The incision was marked on the flexor carpi radialis, starting from 15 mm proximal to the radial styloid (Fig. 1a). The volar locking plate was put on the radius after all muscles, vessels, and nerves of the anterior compartment (except the radial artery) were retracted. To manipulate the volar locking plate more easily, a threaded drill guide is attached. This technique enables the use of a 10 mm approach (Fig. 1b). First, distal locking screws were inserted to fix the plate and the distal fragment. Then, the distal fragment was reduced by the condylar stabilizing technique (Fig. 1c and d) [8]. The skin was closed by a 4–0 nylon thread (Fig. 1e). No wrist immobilization was needed post-operatively.

All patients were monitored for a follow-up of 3 months. The following clinical parameters were assessed: Wrist range of motion; grip strength (as a percentage of the healthy side); visual analog scale (VAS); quick disabilities of the arm, shoulder, and hand (Q-DASH) score; and modified Mayo wrist score. Any complications were also investigated. Radial inclination (RI), ulnar variance (UV), and volar tilt (VT) were evaluated as radiographic parameters in post-operative radiography. Measurements of radiographic parameters were performed as previously described in the literature [9]. Data are presented as the mean ± standard deviation and were analyzed for significant differences by the Mann-Whitney U test (Prism 7, GraphPad Software, San Diego, CA). Differences were considered significant at $P < 0.05$.

Results

In the C group, the wrist range of motion was 75.6° ± 9.9 of

Clinical outcomes	C group	M group	P-value
Flexion (°)	75.6±9.9	75.8±16.0	0.9672
Extension (°)	77.8±8.6	72.1±15.0	0.0801
Pronation (°)	85.2±3.4	85.6±5.4	0.7254
Supination (°)	85.8±10.5	86.9±5.9	0.6298
Grip strength (% of the healthy side)	81.4±21.2	82.4±14.8	0.8419
VAS (0–10)	0.7±1.0	1.1±1.3	0.2621
Q-DASH score (0–100)	8.5±10.7	10.2±15.2	0.6251
Mayo wrist score (0–100)	95.2±5.9	93.2±7.6	0.2908
VT (°)	13.0±3.2	13.2±3.9	0.8706
RI (°)	20.1±3.7	20.2±3.4	0.8751
UV (mm)	-0.7 ±1.2	-0.4 ±1.4	0.46
C group: Conventional approach, M group: 10 mm approach, VAS: Visual analog scale, Q-DASH: Quick disabilities of the arm, shoulder, and hand, N.S.: No significant difference, VT: Volar tilt, RI: Radial inclination, UV: Ulnar variance			

Table 1: Comparison of clinical outcomes between conventional approach and 10 mm approach in this study.

flexion, 77.8° ± 8.6 of extension, 85.2° ± 3.4 of pronation, and 85.8° ± 10.5 of supination, and mean grip strength was 81.4 ± 21.2% compared to the healthy side. VAS, Q-DASH score, and modified Mayo score were 0.7 ± 1.0, 8.5 ± 10.7, and 95.2 ± 5.9, respectively. Plain radiography showed that VT, RI, and UV were 13.0° ± 3.2, 20.1° ± 3.7, and −0.7 ± 1.2 mm, respectively. On the other hand, in the M group, the wrist range of motion was 75.8° ± 16.0 of flexion, 72.1° ± 15.0 of extension, 85.6° ± 5.4 of pronation, and 86.9° ± 5.9 of supination, and the mean grip strength was 82.4 ± 14.8% compared to the healthy side. VAS, Q-DASH score, and modified Mayo wrist score were 1.1 ± 1.3, 10.2 ± 15.2, and 93.2 ± 7.6, respectively. Plain radiography showed that VT, RI, and UV were 13.2° ± 3.9, 20.2° ± 3.4, and −0.4 ± 1.4 mm, respectively (Table 1). There was no significant difference between the groups in all categories. All patients had no complications during the perioperative period.

Discussion

In minimally invasive surgery for distal radius fractures, Imatani et al. and Zenke et al. reported that the advantages of the procedure are that the tissue is less invaded, the post-operative pain is reduced at an early stage, and the wound is small and less noticeable [10, 11]. In a previous study, we reported that there were no difficulties to fix with the volar locking plate, and bone union was achieved in all patients [7].

Surgery with a 10 mm approach for distal radius fractures is a very complicated procedure, and case reports are rare. In the volar approach, there are flexor tendons and the median nerve between the incision and fragments, and these tissues need to be retracted to attach the plate to the fragment [7]. The risks of post-operative flexor tendon injuries and carpal tunnel syndrome are increased if the reduction is poor or the plate is floating because of the complexity of the procedure [12-14]. In addition, the plate is not designed for a 10 mm approach. Despite these complexities, our previous study and the present study found no technical trouble performing surgery with a 10 mm approach [7].

In this study, superior clinical outcomes were obtained in both groups, and there was no significant difference in all categories between the groups. Kodama et al. reported a significant correlation between post-operative plain radiography parameters (VT, UV) and clinical outcomes in volar locking plate fixation for distal radius fractures [15]. In this study, good post-operative clinical outcomes and post-operative plain radiography parameters (VT, RI, and UV) were obtained in all cases. Good alignment was obtained because the included cases had simple dorsal dislocated distal radius fractures (types A2 and C1 according to the AO classification). In addition, since

the detachment of soft tissue was reduced in the minimal incision group, it was possible to obtain a reduction position by ligamentotaxis. Thus, this may explain why good alignment was obtained even in the group receiving surgery with a 10 mm approach [16].

There are some limitations to this study. The first is that the follow-up period was 3 months. Previous studies reported a follow-up period of 12 months or longer for volar locking plate fixation [17, 18]. However, the purpose of this study was to investigate the clinical outcomes and the occurrence of complications in the early post-operative period. Moreover, there are reports that clinical scores, such as the Q-DASH score and Mayo wrist score, which were evaluated in this study, show a ceiling effect 3 months after operation, and recovery of the upper limb function sufficient for returning to daily life is also acquired early, at 3 months after surgery [19, 20]. Therefore, we considered that 3 months was sufficient for the observation period of this study. The second is that it took a long time to acquire the procedure for performing surgery with a 10 mm approach. Our team had undergone many successful surgeries with a 10 mm approach before this study [7, 21]. Although the first cases required a lot of operation time, at the time of this study, all operators were able to perform surgery with a 10 mm approach. Finally, the number of patients was small and insufficient for statistical analysis. The effect size by t-test was d = 0.4662119 and verification power is 1–β = 0.3954425l; thus, the number of cases may have been insufficient to obtain sufficient verification power. Although the maximum possible number of patients was included, in the future, it will be necessary to conduct research using a larger sample of cases.

Conclusion

In this study, the results of early post-operative clinical outcomes were investigated and compared between conventional surgery and surgery with a 10 mm approach for fixation of dorsal displaced distal radius fractures with a volar locking plate. Surgery with a 10 mm approach for distal radius fractures is a very complicated procedure. However, since the detachment of soft tissue was reduced in a 10 mm approach, it was possible to obtain a reduction position by ligamentotaxis. Therefore, this study suggested that a 10 mm approach obtained early post-operative outcomes and alignment comparable to conventional incision surgery.

Clinical Message

In the fixation of dorsal displaced distal radius fractures with a volar locking plate, a 10mm approach can obtain early postoperative outcomes and alignment comparable to conventional incision surgery.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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Conflict of Interest: Nil
Source of Support: Nil

Consent: The authors confirm that informed consent was obtained from the patient for publication of this case report

How to Cite this Article

Kunishige R, Naito K, Obata H, Kawakita S, Suzuki T, Ishijima M. Comparison of Conventional Incision and 10 mm Approach for Volar Locking Plates in Dorsal Displaced Distal Radius Fractures. Journal of Orthopaedic Case Reports 2024 June;14(6):186-190.