Complications of Distal Radius Fractures Treated by Volar Locking Plate Fixation

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abstract

The current study investigated the incidence of complications after surgery for distal radial fractures. This multicenter retrospective study was conducted at 11 institutions. A total of 824 patients who had distal radius fractures that were treated surgically between January 2010 and August 2012 were identified. The study patients were older than 18 years and were observed for at least 12 weeks after surgery for distal radius fractures with a volar locking plate. Sex, age, fracture type according to AO classification, implants, wrist range of motion, grip strength, fracture consolidation rate, and complications were studied. Analysis included 694 patients, including 529 women and 165 men, with a mean age of 64 years. The mean follow-up period was 27 weeks. The fracture consolidation rate was 100%. There were 52 complications (7.5%), including 18 cases of carpal tunnel syndrome, 12 cases of peripheral nerve palsy, 8 cases of trigger digit, 4 cases of tendon rupture (none of the flexor pollicis longus), and 10 others. There was no rupture of the flexor pollicis longus tendon because careful attention was paid to the relationship between the implant and the tendon. Peripheral nerve palsy may have been caused by intraoperative traction in 7 cases, temporary fixation by percutaneous Kirschner wires in 3 cases, and axillary nerve block in 1 case; 1 case appeared to be idiopathic. Tendon ruptures were mainly caused by mechanical stress. [*Orthopedics*. 2016; 39(5):e893-e896.]

The use of volar locking plates for surgical fixation of distal radius fractures has become popular. However, several complications associated with this type of surgery have been reported, including tendon rupture. Rupture of the flexor pollicis longus tendon and the extensor pollicis longus tendon associated with repair of distal radius fractures with such a plate was first reported in 1998[1] and 2000,[2] respectively. The reported incidence of flexor pollicis longus tendon rupture associated with the use of a volar locking plate for distal radius fracture has ranged from 0.3% to 12%.[3,4] To minimize the occurrence of flexor pollicis longus tendon rupture after volar plate fixation of distal radius fractures, the authors paid attention to placement of the plate. In a series of patients with distal radius fractures, the authors investigated annual trends in the number of complications in relation to the treatment measures. The current study investigated the incidence of complications after surgery for distal radial fractures with a volar locking plate.

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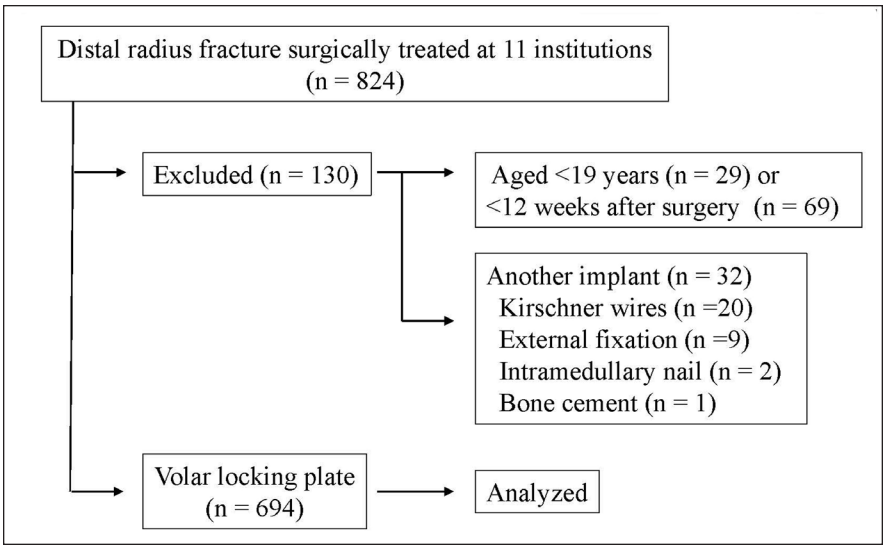

Figure: Study flowchart.

MATERIALS AND METHODS

Patient Selection

The study was approved by the institutional review board of the authors' medical faculty. A multicenter retrospective study was conducted at 11 institutions, including 4 tertiary and 7 secondary emergency care hospitals, as defined by the Japanese Association for Acute Medicine. Databases were searched for all distal radius fractures that were treated surgically between January 2010 and August 2012. A total of 824 patients were identified. Patients included in this study were older than 18 years and were observed for at least 12 weeks after surgery for distal radius fractures with a volar locking plate (**Figure**). Sex, age, fracture type according to AO classification, implants, wrist range of motion, grip strength, fracture consolidation rate, and intra- or postsurgical complications were studied. Grip strength was measured once as a single set with a dynamometer (TKK 5401 Grip-D; Smedley, Takei, Tokyo, Japan).[5] Reduced range of motion was defined as total wrist flexion and extension of less than 90° and/or reduced grip strength of less than 75% compared with the unaffected side, according to the Mayo wrist score.

Surgical Technique

Surgery was performed under fluoroscopic guidance with a volar approach through the flexor carpi radialis flexor sheath. Fracture stabilization was achieved with a volar locking plate. Bone grafting was not performed. Attention was paid to positioning the plate proximal to the watershed line,[6] repair of the pronator quadratus and the intermediate fibrous zone of the distal radius, and early removal of the plate if it was expected to cause irritation of the flexor pollicis longus tendon. The wrist was immobilized postoperatively in a plaster splint for several weeks. Some patients were instructed in active wrist motion exercises immediately after surgery.

RESULTS

This study analyzed 694 patients, including 529 women and 165 men, with a mean age of 64 years (range, 19-92 years) (AO classification: A2, 154; A3, 204; B1, 4; B2, 8; B3, 12; C1, 78; C2, 189; C3, 45). A Stellar plate (Japan Universal Technologies, Tokyo, Japan) was used in 231 cases, a Distal Volar Radius plate (Hand Innovations, Warsaw, Indiana) was used in 137, a Variable Angle Locking Compression plate (VA-LCP; Synthes, West Chester, Pennsylvania) was used in 115, an Acu-Loc plate (Acumed, Hillsboro, Oregon) was used in 93, a Distal Radius plate (Mathys, Salzburg, Austria) was used in 66, a Variable Angle Two-Column Volar Distal Radius plate (VA-TCP; Synthes) was used in 16, and other locking plates were used in 36. A total of 36 orthopedic surgeons participated, including 24 attending surgeons and 12 residents. Mean number of patients per surgeon was 19 (range, 1-54). The period of immobilization with a plaster splint was 0 to 8 weeks (0 weeks, 394 cases; 1 week, 136 cases; 2 weeks, 43 cases; 3 weeks, 37 cases; 4 weeks, 34 cases; 5 weeks, 14 cases; 6 weeks, 33 cases; 7 weeks, 1 case; 8 weeks, 2 cases), with a mean of 2.5 weeks in patients who had a splint. Mean follow-up was 27 weeks (range, 12-156 weeks). Mean total motion of the wrist was 126° (range, 40°-180°). Mean grip strength was 18 kg (range, 0-50 kg) on the affected side and 24 kg (range, 4-56 kg) on the unaffected side. The fracture consolidation rate was 100%. There were 146 implant removals in 694 patients (25%).

There were 52 (7.5% of 694 analyzed) complications, including 18 cases of carpal tunnel syndrome, 12 cases of peripheral nerve palsy (median nerve, 5; radial nerve, 3; ulnar nerve, 3; posterior interosseous nerve, 1), 8 cases of trigger digit, 4 cases of tendon rupture (extensor pollicis longus tendon, 3; flexor digitorum profundus tendon, 1), 3 cases of blister, 3 cases of complex regional pain syndrome, 2 cases of secondary displacement (reoperation), 1 case of ulnar head dislocation, and 1 case of skin pigmentation (**Table 1**). Peripheral nerve palsy may have been caused by intraoperative traction in 7 cases, temporary fixation by percutaneous Kirschner wires in 3 cases, and axillary nerve block in 1 case (ulnar nerve); 1 case (posterior interosseous nerve) appeared to be idiopathic. Peripheral nerve palsy resolved within 8 to 52 weeks (mean, 28 weeks) without inter-

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vention (observation only). Tendon ruptures were mainly caused by mechanical stress (**Table 2**). Two cases of secondary displacement were caused by inadequate plate fixation (intrasurgical complications). One patient had both trigger digit and carpal tunnel syndrome, 48 patients (10% of 470 analyzed) had reduced range of motion, and 125 patients (38% of 333 analyzed) had reduced grip strength.

Table 1

Complications

Complication	No. of Cases	Incidence
Carpal tunnel syndrome	18	2.6%
Peripheral nerve palsy	12	1.7%
Trigger digit	8	1.2%
Tendon rupture	4	0.6%
Extensor pollicis longus	3	0.4%
Flexor digitorum profundus (index)	1	0.1%
Flexor pollicis longus	0	0%
Blister	3	0.4%
Complex regional pain syndrome	3	0.4%
Secondary displacement (reoperation)	2	0.3%
Ulnar head dislocation	1	0.1%
Skin pigmentation	1	0.1%
Total	52	7.5%

Discussion

Flexor pollicis longus tendon rupture is a major complication that can occur after surgical fixation of distal radius fractures with a volar locking plate. The clinical outcome of this type of surgery was first reported in 2002,[7] and in 2003, Drobetz and Kutscha-Lissberg[3] reported 6 cases of flexor pollicis longus tendon rupture in 56 patients (12%) who were treated in this way. The watershed line is a useful surgical landmark for positioning a volar locking plate.[6] Implants placed on or distal to the flexor pollicis longus tendon can impinge on the tendon and cause injury. In 2011, Soong et al[4] reported a lower incidence of flexor pollicis longus tendon rupture (1 of 321 cases, 0.3%). In the current series of 694 cases, no rupture of the flexor pollicis longus tendon occurred because careful attention was paid to the relationship between the implant and the tendon. In a series that used an early volar locking plate design (Mathys),[8] Drobetz and Kutscha-Lissberg[3] reported a high risk of flexor pollicis longus rupture, and in a study conducted with distally placed plates, Casaletto et al[9] reported 7 cases of flexor pollicis longus rupture in a series of 353 patients. However, Asadollahi and Keith[10] showed that flexor pollicis longus rupture can occur with plates of various designs, including new-generation volar locking plates. The current series included 66 patients who were treated with an early design of a volar locking plate and 93 who were treated with distally placed plates.

The reported incidence of extensor pollicis longus rupture is 0.3% for conservative treatment[11] and 0.3% to 8.6% for surgical treatment with a volar locking plate.[4,12] The incidence in the current series was 0.4% (3 of 694 cases). In the current series, 3 cases of extensor pollicis longus tendon rupture were caused by mechanical stress from screw or bone fragments (**Table 1**). The size of Lister's tubercle varies from 2 to 6 mm, and the depth of the extensor pollicis longus groove varies from 1 to 6 mm.[13] Use of the dorsal horizon (tangential) view is a

Table 2

Tendon Rupture

Patient No./Sex/Age, y	Fracture AO Classification	Implant	Rupture Site	Time of Rupture, wk	Cause
1/F/58	A3	Distal radius plate[a]	Flexor digitorum profundus (index)	15	Plate breakout
2/F/56	C2	Stellar plate[b]	Extensor pollicis longus	2	Screw irritation
3/F/57	A3	Stellar plate	Extensor pollicis longus	3	Bone fragments
4/M/61	C3	Acu-Loc plate[c]	Extensor pollicis longus	13	Bone fragments

Abbreviations: F, female; M, male.
[a]*Mathys, Salzburg, Austria.*
[b]*Japan Universal Technologies, Tokyo, Japan.*
[c]*Acumed, Hillsboro, Oregon.*

useful means of preventing protrusion of the screw beyond the dorsal cortex when performing osteosynthesis of the distal radius.[14]

Carpal tunnel syndrome is a recognized complication of distal radius fracture, and its reported incidence in this setting is 17% (37 of 213 cases) for conservative treatment[15] and 6.1% (3 of 49 cases) for operative treatment.[16] In the current series, the incidence was 2.6% (18 of 694 cases). Previous studies identified an association between trigger digit and carpal tunnel syndrome.[17] Both conditions are caused by limited space in an enclosed anatomic region, and they often coexist, suggesting a common pathophysiologic process. In the current series, the incidence of trigger digit was 1.2% (8 of 694 cases). The overall complication rate has been variable, perhaps reflecting differences in the way that complications are defined.

Limitations

The current study had several limitations. First, identification of complications was dependent on the medical records, complications were defined by individual attending surgeons, and the follow-up period was relatively short. Second, the authors were unable to gather all clinical data for the patients. In a total of 694 patients, range of motion was recorded for 470 and grip strength was recorded for 333. However, this study included a large proportion of the local population; therefore, the results adequately reflect the surgical care of local patients with distal radius fractures.

Conclusion

There was a complication rate of 7% in the current series of patients with distal radius fractures treated with surgical fixation with a volar locking plate. Complications included carpal tunnel syndrome, peripheral nerve palsy, trigger digit, and tendon rupture. The watershed line is a useful surgical landmark for positioning a volar locking plate. No cases of flexor pollicis longus tendon rupture occurred among the 694 patients because careful attention was paid to the relationship between the implant and the tendon.

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