Volar Locking Plate Fixation of Distal Radius Fractures: Splint versus Immediate Mobilization

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Abstract

Background The goal of this study was to demonstrate that the use of a splint after performing an osteosynthesis of the distal radius with a volar locking plate is unnecessary. The main hypothesis was that postoperative flexion of the wrist was greater without a splint. Secondary hypothesis was that patients who were allowed immediate mobilization got better results in terms of pain, Quick Disabilities of the Arm, Shoulder and Hand (DASH), Patient-Rated Wrist Evaluation (PRWE), strength, extension, pronation, and supination.

Case Description Our series included 72 patients, aged 59 years in average of which 59 were female patients. All patients had been operated for a volar locking plate fixation of a distal radius fracture. The first 36 patients (group I) were immobilized by a splint at 30° of extension of the wrist for 2 weeks. The following 36 patients (group II) were not immobilized.

Results At 3 months, all the average variables were better in the group without splint (group I: flexion 74.83%, extension 83.13%, pronation 92.07%, supination 88.11%, pain 1.72/10, Quick DASH 21.78/100, PRWE 22.97/100, strength 62.96%; group II: flexion 85.50%, extension 83.4%, pronation 92.96%, supination 92.96%, pain 1.28/10, Quick DASH 19.57/100, PRWE 20.56/100, strength 66.34%). No complication was reported.

Conclusion Overall, our results demonstrate that wearing a splint after volar locking plate fixation of a distal radius fracture is unnecessary.

Keywords

- volar plate
- distal radius fractures
- splint
- mobilization

The most common surgical treatment of unstable distal radius fractures is the open reduction and internal fixation with a volar locking plate.^{1,2} The main reason being that the stability of this osteosynthesis enables an early mobilization of the wrist.^{3–5} Yet, this advantage is generally not used by many authors who continue to recommend wearing a splint postoperatively.⁶ Only a few authors recommend an immediate mobilization of the wrist without a splint.⁷ The goal of this study was to demonstrate that the use of a splint following volar locking plate fixation of a distal radius fracture is unnecessary.

Because flexion is the most affected motion after dorsally displaced radius fracture, the main hypothesis was that the range of motion of the wrist in flexion following volar locking plate fixation of a distal radius fracture would be superior at mid-term when immediate mobilization was advised compared with when a postoperative splint was prescribed.

Secondary hypotheses were that pain, Quick Disabilities of the Arm, Shoulder and Hand (DASH), Patient-Rated Wrist Evaluation (PRWE), grip strength, range of motion of the wrist in extension, pronation, and supination after volar

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locking plate fixation of a distal radius fracture would be better at mid-term when immediate mobilization was advised compared with when a postoperative splint was prescribed.

Materials and Methods

All medical files of patients treated in our department for a distal radius fracture between October 2016 and February 2017 were reviewed. We excluded patients aged less than 18 years, pregnant women, patients with pathologic and/or bilateral and/or open fractures, nondisplaced fractures, multiple injury patients, and patients with incomplete medical files. Our series included 72 patients aged 59 years in average ranging from 21 to 92 years. Among those 72 patients, 54 were females and 18 were males (► **Tables 1** and **2**).

All patients were operated in delayed emergency (1–3 days) under regional anesthesia, in outpatient surgery using a volar locking plate (Initial R, Newclip Technics, Haute Goulaine, France) and a minimally invasive approach.⁷ The first 36 patients (group I) were prescribed a splint at 30° of extension of the wrist for 2 weeks followed by self-rehabilitation. The 36 following patients (group II) were prescribed immediate mobilization.

The method of evaluation consisted in the mid-term evaluation (12–24 weeks postoperative) of the range of motion of the wrist in flexion, extension, pronation, and supination (expressed in percentage compared with the contralateral side), numeric pain scale ranging from 0 (no pain) to 10 (maximum imaginable pain) as Visual Analogue Scale (VAS), Quick DASH ranging from 0 (normal function of the upper limb) to 100 (nonfunctional upper limb), PRWE ranging from 0 to 100,⁸ and grip strength on a Jamar dynamometer in position 2 (Sammsons Preston Ryolan, Bolingbrook, IL) expressed in percentage compared with the contralateral side. Complications were recorded.

The statistical analysis consisted, after demonstrating that the two groups were comparable, in comparing the averages of eight nonmatched, quantitative variables at 3 months postoperative: range of motion of the wrist in flexion, extension, pronation, supination, pain, Quick DASH, PRWE, and grip strength.

Given the small sample of our series, older “frequentist” methods of analysis, expressed in *p*-values, only had low statistical power. In this study, we used new methods called “Bayesian methods of analysis,” consisting in observing the distribution of a T coefficient in the model and calculating the probability to observe or not a difference, with a greater statistical power. This probability between 0 and 1 is more precise than a mere binary $p < 0.05$ or $p > 0.05$. If the interval of the T coefficient did not include 0 and if the probability was greater than 95%, the difference was considered as statistically significant.

Results

The results of the statistical analysis are presented in ► **Tables 3** and **4**.

At 3 months postoperative, the average range of motion of the wrist in flexion was 74.83% in group I and 85.50% in group II. The difference was significant because the credible interval of the difference did not include 0 (1.1; 15.4). The average

Table 1 Casuistry of 36 patients presenting distal radius fractures treated by volar locking plated fixation and postoperative splint (group I)

Patient	Age	Gender	Dominance	Injured side	AO classification
(n)	(y)	(M/F)	(R/L)	(R/L)	(A/B/C)
1	80	F	R	R	C1.2
2	64	F	R	R	C1.2
3	66	F	R	G	A2.2
4	79	F	R	R	C2.2
5	52	F	R	R	A3.2
6	68	F	R	L	A2.2
7	69	F	R	R	A2.2
8	61	F	R	R	A2.2
9	63	F	R	L	C2.2
10	56	F	R	L	A2.2
11	53	F	L	R	A2.2
12	39	M	R	R	C1.3
13	67	F	R	L	C2.2
14	53	M	R	L	C2.2
15	54	M	R	L	C3.1
16	37	F	L	L	C3.1
17	38	M	R	R	C2.2
18	60	M	R	R	A2.2
19	50	F	R	R	A2.2
20	71	F	R	L	A2.2
21	22	F	R	L	C1.2
22	87	F	R	L	A3.3
23	70	F	R	L	C1.2
24	53	F	R	L	A2.3
25	59	F	R	L	C3.1
26	43	F	R	R	A2.2
27	56	F	R	L	C3.1
28	55	F	R	R	C1.3
29	79	F	R	L	A2.1
30	53	F	R	L	A2.2
31	62	M	R	L	C2.2
32	68	F	R	L	A2.3
33	50	F	R	L	A2.3
34	48	F	R	R	B3.2
35	21	M	R	L	C3.1
36	65	F	R	R	A2.2

Abbreviations: F, female; L, left; M, male; R, right.

range of motion of the wrist in extension was 83.13% in group I and 83.4% in group II. The difference was not significant as the credible interval of the difference included 0 (−6.7; 6.5). The average range of motion of the wrist in pronation was 92.07% in group I and 92.96% in group II. The difference was not significant as the credible interval of the difference included 0 (−3.7; 6). The average range of motion of the

Table 2 Casuistry of 36 patients presenting distal radius fractures treated by volar locking plated fixation and immediate postoperative mobilization (group II)

Patient	Age	Gender	Dominance	Injured side	AO classification
(n)	(y)	(M/F)	(R/L)	(R/L)	(A/B/C)
1	50	M	R	L	C2.1
2	51	F	R	R	A2.2
3	84	M	R	R	A3.3
4	90	F	R	L	C2.1
5	67	F	R	R	A2.2
6	66	F	R	R	A2.2
7	74	M	R	L	C1.2
8	55	F	R	L	A2.2
9	92	F	R	R	A2.2
10	55	M	R	L	C2.1
11	77	F	R	L	C1.2
12	59	F	R	L	C2.1
13	66	F	L	L	A3.2
14	68	F	R	L	A2.2
15	48	F	R	R	C1.2
16	53	F	R	L	A2.2
17	28	M	R	L	C1.2
18	63	F	R	L	C1.3
19	51	F	R	R	C1.2
20	68	F	R	L	A2.2
21	45	M	R	R	C1.2
22	27	F	R	R	A2.1
23	58	M	R	L	A2.2
24	63	F	R	L	A3.2
25	21	M	R	R	A2.2
26	80	F	R	L	A2.2
27	45	M	L	L	A2.2
28	45	M	R	L	A2.2
29	79	F	R	L	C1.3
30	86	F	L	R	A3.2
31	50	F	R	R	A2.2
32	64	F	R	L	A2.2
33	48	M	L	L	C1.2
34	85	F	R	R	A3.3
35	52	F	R	R	C2.1
36	74	F	R	R	C1.2

Abbreviations: F, female; L, left; M, male; R, right.

wrist in supination was 88.11% in group I and 92.96% in group II. The difference was not significant as the credible interval of the difference included 0 (−0.9; 8.8).

The average pain in VAS was 21.78/100 in group I and 19.57/100 in group II. The difference was not significant as

the credible interval of the difference included 0 (−1.06; 0.2). The average Quick DASH was 1.72/10 in group I and 1.28/10 in group II. The difference was not significant as the credible interval of the difference included 0 (−12.3; 2.8). The average Quick PRWE was 22.97/100 in group I and 20.56/100 in group II. The difference was not significant as the credible interval of the difference included 0 (−9.6; 6.7). The average grip strength was 62.96% in group I and 66.34% in group II. The difference was not significant as the credible interval of the difference included 0 (−7.2; 11.7).

No complications or surgical revision was reported for either group.

Discussion

The advent of locking plates has made possible early postoperative mobilization even for supporting articulations such as the ankle,⁹ the femur,¹⁰ and in osteoporotic patients.¹¹ For the wrist, some biomechanical studies have shown that the stability of a volar locking plate fixation of a distal radius fracture was sufficient to enable immediate mobilization.^{3,12} Others have shown that the use of a splint or a cast does not prevent from secondary displacement.¹³

Despite the demonstrated stability of volar locking plates of the distal radius, many authors still recommend an immobilization by a splint,^{14–19} whereas their irrelevance has been demonstrated for less stable means of fixation such as external fixators²⁰ or K-wires.^{21,22} Only a few authors recommend an early postoperative mobilization.^{7,23} No study has yet compared the results of early mobilization to the results of an immobilization by a splint after a volar locking plate fixation of a distal radius fracture.

Our results show that all clinical variables were better without a postoperative splint, among them only postoperative flexion was statistically significant. Among the weaknesses of our study, we noted the small size of our sample, and the fact that we limited the postoperative immobilization to 2 weeks when some authors recommend it²⁴ for up to 6 weeks.⁶ The average follow-up of 3 months of our series could be considered insufficient but some authors have demonstrated that the result at 2 months could be correlated to the results at 1 year.²⁵ Among the strength of this study, we noted that it was the only study to compare postoperative immobilization to a complete absence of immobilization. The other studies compared physical therapy associated to a splint versus strict immobilization by a cast²⁴ or a splint.²⁶

The main hypothesis of this study was verified as the range of motion in flexion after a volar locking plate fixation of a distal radius fracture was superior at 3 months when immediate mobilization was prescribed compared with when a postoperative splint was used. Secondary hypotheses were not verified since the difference for pain, Quick DASH, PRWE, grip strength, range of motion in extension, pronation, and supination after a volar locking plate fixation of a distal radius fracture were not statistically significant.

All in all, our results demonstrate that the use of a splint after volar locking plate fixation of a distal radius fracture is unnecessary.

Table 3 Results at 3 months of 36 patients presenting distal radius fractures treated by volar locking plated fixation and postoperative splint (group I)

Patient	Follow-up	Passive motion				Pain	Quick DASH	PRWE	Jamar
(n)	(wk)	%				(0–10)	(0–100)	(0–100)	%
		F	E	P	S				Position 2
1	12	62.5	71.4	100	100	0	27.27	36	42.8
2	12	87.5	66.6	100	100	1	9.09	3	100
3	12	100	87.5	93.7	94.1	1	13.64	18	36.3
4	12	52.9	41.6	100	83.3	4	15.91	35	59.2
5	12	93.7	93.7	100	93.7	5	61.36	12	100
6	15	85.7	75	100	100	1	22.73	41	50
7	12	85.7	64.2	75	77.7	5	40.91	37	50
8	13	77.7	75	100	87.5	2	25	52	83.3
9	12	88.8	77.7	77.7	93.7	0	4.55	3	71.4
10	16	100	100	100	100	2	6.82	7	75
11	12	100	93.3	100	100	0	11.36	11	68.9
12	16	82.3	93.75	82.3	62.5	1	13.64	6	100
13	12	78.5	100	81.2	100	1	13.64	11	58.3
14	12	82.3	100	93.7	94.1	0	6.82	10	68.1
15	12	50	83.3	87.5	75	6	68.18	70	6.6
16	12	23.5	71.4	93.75	56.2	1	6.82	16	50
17	12	53.8	62.5	100	80	1	36.36	35	85.7
18	10	87.5	92.8	100	100	0	13.64	28	33.3
19	12	88.2	66.6	93.7	94.1	0	4.55	1	88.9
20	12	37.5	100	100	80	1	40.91	52	20.6
21	12	100	100	100	94.1	0	2.27	5	76.9
22	12	87.5	85.7	100	94.1	0	0	0	100
23	12	87.5	100	100	100	0	0	1	100
24	12	68.7	85.7	80	77.7	1	6.82	5	82.1
25	12	50	76.9	56.2	44.4	0	36.36	47	32
26	12	87.5	88.2	100	100	1	6.82	7	80
27	12	85.7	100	100	85.7	1	54.55	22	25
28	12	14.2	56.2	50	66.6	6	56.82	77	0.05
29	12	88.2	100	100	93.7	2	18.18	28	47
30	12	68.7	85.7	93.75	100	2	20.45	29	50
31	12	81.2	100	87.5	100	4	15.91	21	100
32	12	50	50	93.7	75	2	29.55	28	62.5
33	12	75	91.6	100	93.3	10	84.09	61	18.1
34	12	70.5	87.5	87.5	94.4	1	4.55	7	85.7
35	12	100	100	100	100	0	0	0	97.5
36	12	61.1	68.7	87.5	81.2	0	4.55	5	61.5

Abbreviations: DASH, Disabilities of the Arm, Shoulder and Hand; E, extension; F, flexion; P, pronation; PRWE, Patient-Rated Wrist Evaluation; RI, radial inclination; S, supination; UI, ulnar inclination.

Note: % = % compared with contralateral healthy side. Extra incision size in case of need an extra incision for proximal screw insertion. Total incision size means main incision size + extra incision size.

Table 4 Results at 3 months of 36 patients presenting distal radius fractures treated by volar locking plated fixation and immediate postoperative mobilization (group II)

Patient	Follow-up	Passive motion				Pain	Quick DASH	PRWE	Jamar
(n)	(wk)	%				(0–10)	(0–100)	(0–100)	%
		F	E	P	S				Position 2
1	12	100	100	100	92.9	2	9.091	21	46.2
2	12	83.3	73.7	100	100	5	63.64	56	60
3	12	76.9	83.3	75	100	0	38.64	24	75
4	12	53.85	60	82.4	68.8	0	34.09	31	28.6
5	12	58.8	44.4	66.7	94.4	4	11.36	24	94.4
6	12	100	100	100	94.4	0	22.73	14	76.9
7	12	100	88.2	100	100	3	27.27	27	83.3
8	12	83.3	94.4	100	88.2	4	38.64	45	63.6
9	12	93.3	100	100	100	1	6.818	11	90.9
10	12	55.6	61.1	83.3	72.2	1	25	19	55.9
11	12	94.4	88.9	94.4	94.2	0	6.818	6	63.7
12	12	70.6	70.6	94.2	83.3	0	2.2273	22	46.2
13	24	94.2	80	100	100	1	36.36	33	66.7
14	12	94.2	94.2	88.9	88.9	3	18.18	22	50
15	24	93.8	100	93.8	93.3	0	0	0	75
16	12	100	100	100	100	1	18.18	19	69.2
17	12	83.3	64.7	88.9	83.3	0	11.36	35	52.4
18	16	100	100	100	100	0	9.09	6	86.4
19	16	100	100	100	100	1	4.55	11	92.9
20	16	82.4	94.2	100	100	0	11.36	5	76
21	12	85.7	70	86.7	88.2	1	40.91	33	41.2
22	16	100	100	87.5	100	0	0	1	93.6
23	12	85.7	100	100	100	8	20.45	25	54.54
24	12	82.4	85.7	100	100	1	20.45	13	80
25	12	93.8	100	100	83.3	0	11.36	27	92.3
26	16	64.3	66.7	92.3	70.6	3	29.55	34	75
27	16	100	100	87.5	100	0	2.273	0	86.4
28	12	100	100	100	100	0	0	3	74.1
29	12	76.5	71.4	93.3	82.4	0	15.91	20	37.1
30	16	100	66.7	100	93.3	0	4.545	9	38.9
31	12	100	86.7	100	100	5	63.64	53	72.7
32	12	81.3	100	100	100	1	25	19	70
33	12	87.5	64.3	100	93.8	0	9.09	27	45.45
34	16	66.7	62.5	56.3	87.5	1	38.64	20	41.7
35	12	83.3	77.8	94.2	77.8	0	20.45	24	92.9
36	12	52.9	52.9	81.3	83.3	0	6.818	1	38.9

Abbreviations: DASH, Disabilities of the Arm, Shoulder and Hand; E, extension; F, flexion; P, pronation; PRWE, Patient-Rated Wrist Evaluation; RI, radial inclination; S, supination; UI, ulnar inclination.

Note: % = % compared with contralateral healthy side. Extra incision size in case of need an extra incision for proximal screw insertion. Total incision size means main incision size + extra incision size.

Conflict of Interest

P.L. has conflict of interest with Newclip Technics, Argo-medical, Biomodex, and Zimmer Biomet. None of the other authors have any conflict of interest.

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