The Necessity of Bone Substitutes for Low-Energy Comminuted Distal Radius Fractures among Elderly Women Treated with Volar Locking Plate Fixation: A Propensity Score-Based Analysis

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INTRODUCTION:

The utility of volar locking plate (VLP) fixation for osteoporotic distal radius fractures has been well-established. However, significant correction loss in certain groups of patients was also reported. Previous studies demonstrated several risk factors for correction loss, including dorsally displaced fractures, osteoporosis, comminuted fractures, and fractures with large fracture void, and unsatisfactory implant placement causing a large distance between the distal locking screws and the articular surface. Artificial bone substitutes are commonly used to fill the fracture void, and bone substitutes may also potentially contribute to supporting distal screw position, keeping them close to the artificial surface. In this retrospective study, we hypothesized that artificial bone substitute may contribute to keeping the distal screws close to the surface and preventing correction loss among elderly women with intraarticular comminuted distal radius fractures, and conducted a comparative analysis using propensity score for bone substitute use.

METHODS:

The ethics board of our institution approved this study. A total of 377 wrists with distal radius fractures treated with VLP at our hospital between 2018 and 2022 were retrospectively reviewed. Among them, 113 cases were among elderly women aged 65 years and older who had comminuted intra-articular fractures (AO type B3, C2, and C3). These patients were followed up and included in the propensity score calculation for bone substitute use. All patients were treated with VLP using the double-tiered subchondral support technique. The outcome measures were set as bone union, Mayo Wrist Score, postoperative grip strength, range of motion, and radiological parameters including volar tilt, radial inclination, and ulnar variance. Patients were divided into two groups based on artificial bone substitute use status. The group in which artificial bone substitute was used was designated Group A, while the group in which no artificial bone substitute was used was designated Group N. Outcomes were compared between these groups. Since the decision to use artificial bone substitute was based on the operating surgeon's discretion, the propensity score for bone substitute use was calculated and the outcomes were compared between propensity score-matched groups. As a sensitivity analysis, regression analysis with inverse probability of treatment weighting (IPTW) using propensity score was also performed. The statistical significance was set at the level of $p<0.05$.

RESULTS:

Group A included 63 patients, and the remaining 50 patients were categorized into group N. The mean ages were 75.1 and 75.2 years, respectively. After propensity score matching, each group included 35 patients and background factors were well-balanced in terms of age, fracture type, and preoperative radiological parameters. Bone union was observed in all patients. Group A demonstrated a significantly smaller postoperative screw-joint surface distance. However, no significant differences were observed in other clinical outcomes between these two groups. The regression analyses with IPWT including all patients demonstrated that only postoperative screw-joint surface distance showed a significant difference.

DISCUSSION AND CONCLUSION:

The use of artificial bone substitute to fill a fracture void was associated with a closer screw placement to the joint, but was not significantly associated with the prevention of postoperative correction loss or other clinical outcomes. Since clinical outcomes were similarly good regardless of its usage, artificial bone substitute may not be necessary for low-energy comminuted intraarticular fractures in elderly women. Further research is needed to determine the role of artificial bone substitute for other patient populations, such as young individuals, male patients, or patients in cases involving high-energy trauma.

[Table 1: Comparison of factors before and after propensity score matching]

		All patients			PS matched		
		Group N	Group A	p-value	Group N	Group A	p-value
		(n=50)	(n=63)		(n=35)	(n=35)	
Age (median [IQR])		75.00 [66.00, 89.00]	76.00 [65.00, 86.00]	0.792	74.74 (5.86)	74.46 (5.92)	0.958
Side (%)	L	27 (54.0)	39 (61.9)	0.445	18 (51.4)	18 (51.4)	>0.999
	R	23 (46.0)	24 (38.1)		17 (48.6)	17 (48.6)	
AO classification (%)	B3	5 (10.0)	4 (6.3)	0.180	0 (0.0)	0(0.0)	0.208
	C2	29 (58.0)	28 (44.4)		20 (57.1)	26 (74.3)	
	C3	16 (32.0)	31 (49.2)		15 (42.9)	9 (25.7)	
Nonaffected grip strength (kg) (mean (SD))		15.71 (4.76)	16.65 (4.81)	0.299	16.11 (4.12)	16.32 (5.33)	0.892
Preoperative radial inclination (RI) (degrees) (median [IQR])		21.00 [3.00, 31.00]	16.00 [1.00, 27.00]	0.001	19.00 [14.00, 22.00]	17.00 [13.00, 22.00]	0.724
Preoperative ulnar variance (UV) (degrees) (median [IQR])		2.28 [-2.01, 6.00]	2.38 [-1.29, 9.88]	0.617	2.31 [1.58, 4.19]	2.44 [1.58, 4.10]	0.810
Preoperative volar tilt (VT)(degrees) (median [IQR])		-4.00 [-32.00, 29.00]	-4.00 [-48.00, 39.00]	0.777	-10.00 [-20.00, 5.50]	-11.00 [-18.50, 4.80]	0.981

[Table 2: Comparison of Main Outcomes after Propensity Score Matching]

	Group N	Group A	p-value
	n=35	n=35	
Total Mayo Wrist Score (median [IQR])	90.00 [82.50, 100.00]	90.00 [85.00, 100.00]	0.673
Postoperative grip strength (% of unaffected side) (median [IQR])	88.24 [58.33, 100.00]	91.67 [65.14, 100.00]	0.444
Postoperative RI(degrees) (median [IQR])	24.00 [21.00, 25.00]	25.00 [21.00, 27.00]	0.168
Final follow-up RI (degrees) (median [IQR])	24.00 [22.00, 27.00]	25.00 [21.00, 27.00]	0.823
Difference between final follow-up RI and postoperative RI (degree) (median [IQR])	1.00 [-1.00, 2.50]	0.00 [-1.50, 1.00]	0.154
Postoperative UV (degrees) (median [IQR])	0.00 [-0.84, 1.55]	0.66 [-0.64, 1.43]	0.902
Final follow-up UV (degrees) (median [IQR])	1.22 [0.26, 2.53]	1.22 [-0.03, 2.47]	0.672
Difference between final follow-up UV and postoperative UV (degree) (median [IQR])	1.08 [0.36, 1.63]	0.67 [0.33, 1.41]	0.372
Postoperative VT (degrees) (median [IQR])	8.00 [6.00, 11.00]	8.00 [5.50, 9.00]	0.233
Final follow-up VT (degrees) (median [IQR])	8.00 [5.00, 11.00]	9.00 [6.50, 10.00]	0.782
Difference between final follow-up VT and postoperative VT (degrees) (median [IQR])	0.00 [-3.00, 2.00]	1.00 [0.00, 3.00]	0.087
Distance from the central point of the articular surface to the most distal screw (mm) (median [IQR])	0.91 [0.54, 1.52]	0.74 [0.30, 1.15]	0.120
Distance from the articular surface to the posterior aspect to the most distal screw (mm) (median [IQR])	1.33 [0.84, 1.56]	0.77 [0.52, 1.10]	0.002