Outcomes and Complications of Selected Intercarpal Fusions Using Various Fixation Devices

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INTRODUCTION:

We evaluated outcomes of various fixation devices in intercarpal fusion for Scaphoid Nonunion Advanced Collapse (SNAC) wrist. We hypothesized that headless compression screw fixation is superior to staples or K-wire fixation in terms of faster operative time, higher union rates, fewer complications, lower reoperation rates, and Patient-Reported Outcomes Measurement Information System (PROMIS) scores.

METHODS:

This retrospective cohort study, approved by the institutional review board, included patients over 18 treated for elective intercarpal fusion for SNAC wrist from 2014 to 2024, identified using CPT codes 25820 and 25825. Out of 90 patients, 29 were excluded because they underwent total wrist fusion or lunate excision, scaphoid-capitate fusion. We reviewed surgical procedures, implants used, discharge disposition, hardware failure, union rates, surgical revision needs, pain scores, infections, and other complications. Functional outcome scores, including PROMIS data, were analyzed preoperatively and postoperatively at 2 weeks, 6 weeks, 3 months, 6 months, 1 year, and 2 years. Confounding factors included age, hand dominance, gender, smoking status, diabetes, inflammatory conditions, and operation time. Chi-squared and Kruskal-Wallis tests compared categorical and continuous variables, respectively. Mixed effects linear regression models, with a random intercept at the patient level, examined associations between PROMIS T-scores and fixation techniques while adjusting for the above confounding variables. Analysis was conducted using Stata 16.1 (StataCorp, College Station, TX).

RESULTS:

There was a total of 61 patients that met the inclusion criteria with 57.3% in the Staples group, 16.3% in the plate or K-wire group, 14.7% in the headless compression screw group and 11.4% in the fusion cup group. The mean follow-up was 48.47 months (range 3 to 169 months). Screw fixation had the lowest complication rate (11%) and a 100% union rate. Staple fixation was used in 35 patients with a 91% union rate and a 23% complication rate. Fusion cup fixation was performed in 7 patients with an 86% union rate and a 57% complication rate. Plate and K-wire fixation had the highest complication rate (70%), despite a 0% reoperation rate, due to superficial pin site infections resolved by antibiotics. Regression analysis showed diabetes had significant negative impact on all PROMIS domain T-scores at least 90 days postoperatively, while smoking did not significantly affect outcomes.

DISCUSSION AND CONCLUSION:

We observed higher complication and reoperation rates with fusion cups due to hardware irritation/impingement, cartilage wear, and lunate fragmentation, leading to revision total wrist fusion. Headless compression screws demonstrated superior performance in terms of higher union rates and lower complications compared to other fixation methods. Additionally, diabetes and male gender had statistically significant impacts on PROMIS outcomes. Generally, patients fared well post-surgery with low non-union rates. Despite this being one of the larger single institution series with longitudinal follow-up, there are limitations to this study. Fixation method was determined by the surgeon based on preference and therefore surgical technique and experience was not controlled for. Furthermore, within each fixation method, implants from different manufacturers were grouped together without categorical analysis comparing each one. Even though discrepancies between the numbers in each fixation group, preferences among different attending physicians, and data heterogeneity limited our analysis, we were still able to obtain valuable information comparing the aforementioned fixation devices in intercarpal fusions.

Table 1: Complication rates and reoperation

Fixation Technique	Staple	Plate or K-Wire	Screw	Fusion Cup	Total	P-Value
Total, N (%)	35 (57.38)	10 (16.39)	9 (14.75)	7 (11.48)	61 (–)	–
Union, N (%)						0.753
No	3 (8.57)	1 (10.00)	0 (0.00)	1 (14.29)	5 (8.20)	
Yes	32 (91.43)	9 (90.00)	9 (100.00)	6 (85.71)	56 (91.80)	
Complication, N (%)						0.009
No	27 (77.14)	3 (30.00)	8 (88.89)	3 (42.86)	41 (67.21)	
Yes	8 (22.86)	7 (70.00)	1 (11.11)	4 (57.14)	20 (32.79)	
Reoperation, N (%)						0.004
No	33 (94.29)	10 (100.00)	9 (100.00)	4 (57.14)	56 (91.80)	
Yes	2 (5.71)	0 (0.00)	0 (0.00)	3 (42.86)	5 (8.20)	

Table 2: Demographic information and hand dominance

Fixation Technique	Staple	Plate or K-Wire	Screw	Fusion Cup	Total	P-Value
Total, N (%)	35 (57.38)	10 (16.39)	9 (14.75)	7 (11.48)	61 (–)	–
Age at index surgery, Mean (SD)	54.00 (13.88)	55.00 (15.23)	61.89 (8.85)	57.86 (9.49)	55.77 (13.10)	0.404
Gender, N (%)						0.123
Female	12 (34.29)	7 (70.00)	2 (22.22)	2 (28.57)	23 (37.70)	
Male	23 (65.71)	3 (30.00)	7 (77.78)	5 (71.43)	38 (62.30)	
Dominant Hand, N (%)						0.955
Left	3 (8.57)	1 (10.00)	1 (11.11)	1 (14.29)	6 (9.84)	
Right	32 (91.43)	8 (80.00)	7 (77.78)	5 (71.43)	52 (85.25)	
Laterality, N (%)						0.499
Left	20 (57.14)	6 (60.00)	4 (44.44)	2 (28.57)	32 (52.46)	
Right	15 (42.86)	4 (40.00)	5 (55.56)	5 (71.43)	29 (47.54)	
Operation on Dominant Hand, N (%)						0.216
No	19 (54.29)	4 (40.00)	2 (22.22)	1 (14.29)	26 (42.62)	
Yes	16 (45.71)	5 (50.00)	6 (66.67)	5 (71.43)	32 (52.46)	

Table 3: Smoking, diabetes, inflammatory arthropathy status, complications, and rre and post-operative ROM.

Fixation Technique	Staple	Plate or K-Wire	Screw	Fusion Cup	Total	P-Value
Smoking Status, N (%)						0.012
No	21 (60.00)	8 (80.00)	8 (88.89)	1 (14.29)	38 (62.30)	
Yes	14 (40.00)	2 (20.00)	1 (11.11)	6 (85.71)	23 (37.70)	
Diabetes Status, N (%)						0.957
No	29 (82.86)	8 (80.00)	8 (88.89)	6 (85.71)	51 (83.61)	
Yes	6 (17.14)	2 (20.00)	1 (11.11)	1 (14.29)	10 (16.39)	
Inflammatory Arthropathy, N (%)						0.204
No	35 (100.00)	9 (90.00)	8 (88.89)	7 (100.00)	59 (96.72)	
Yes	0 (0.00)	1 (10.00)	1 (11.11)	0 (0.00)	2 (3.28)	
Operative time (min)$_{rre}$ Mean (SD)	112.37 (21.14)	125.70 (26.52)	93.78 (45.87)	124.29 (18.11)	113.18 (27.74)	0.065
Return to Work, N (%)						0.168
No	5 (14.29)	2 (20.00)	0 (0.00)	3 (42.86)	10 (16.39)	
Yes	21 (60.00)	5 (50.00)	7 (77.78)	3 (42.86)	36 (59.02)	
Follow-up Time (Months), Mean (SD)	48.13 (39.94)	52.70 (53.25)	58.05 (57.44)	33.15 (16.04)	48.47 (42.58)	0.980
Wrist preop flexion extension arc, Mean (SD)	80.00 (33.74)	82.50 (24.52)	50.00 (27.84)	56.00 (37.65)	74.79 (32.95)	0.124
Wrist post op flexion extension arc, Mean (SD)	67.92 (15.49)	90.00 (.)	60.00 (26.77)	74.17 (40.30)	69.08 (24.75)	0.705

Table 4: Linear regression models used for all PROMIS outcomes. (* p-value <0.001, ** p-value < 0.01, * p-value < 0.05)**

	Mean Operation Time (min)	PROMIS Physical Function	PROMIS Pain Interference	PROMIS Depression	PROMIS Upper Extremity
Fixation Technique					
Staple	ref.	ref.	ref.	ref.	ref.
Plate or K-Wire	10.01 (-0.09, 40.11)	5.83** (1.44, 10.15)	-2.83 (-5.92, 0.67)	5.67 (-4.02, 11.36)	4.52 (-0.55, 9.58)
Screw	-17.83 (-39.15, 3.48)	3.35 (-1.13, 7.84)	-3.81* (-7.28, -0.44)	-4.45 (-12.06, 3.16)	-0.98 (-6.94, 4.99)
Fusion Cup	12.98 (-10.27, 36.18)	-5.79 (-13.59, 2.02)	7.13* (1.00, 13.25)	8.70 (-3.78, 21.19)	Insufficient Counts
Gender					
Female	ref.	ref.	ref.	ref.	ref.
Male	14.68 (-0.81, 29.74)	4.28* (0.91, 7.65)	-0.46 (-2.96, 2.05)	-4.39 (-10.14, 1.37)	7.48*** (3.87, 11.10)
Age at index surgery	-0.11 (-0.66, 0.43)	-0.07 (-0.19, 0.04)	0.01 (-0.08, 0.10)	-0.20* (-0.40, -0.00)	-0.04 (-0.18, 0.09)
Operative time (rre)	N/A	0.03 (-0.03, 0.09)	-0.05* (-0.10, -0.00)	0.08 (-0.04, 0.19)	-0.02 (-0.10, 0.06)
Smoking Status					
No	ref.	ref.	ref.	ref.	ref.
Yes	-2.96 (-18.67, 12.75)	-0.37 (-3.72, 2.98)	0.28 (-2.28, 2.81)	0.32 (-5.42, 6.06)	-0.19 (-4.17, 3.80)
Diabetes Status					
No	ref.	ref.	ref.	ref.	ref.
Yes	2.65 (-16.15, 21.46)	-7.09*** (-11.04, -3.15)	6.64*** (3.67, 9.60)	8.12* (1.26, 14.98)	-9.56*** (-13.30, -5.82)
Inflammatory Arthropathy					
No	ref.	ref.	ref.	ref.	ref.
Yes	-20.70 (-61.70, 20.30)	8.60 (-1.53, 14.74)	-5.20 (-11.23, 0.84)	0.26 (-14.04, 14.56)	5.83 (-9.66, 19.33)
Postop Evaluation					
No	N/A	ref.	ref.	ref.	ref.
Yes		0.76 (-1.46, 2.98)	-2.20* (-4.13, -0.27)	-5.06** (-9.27, -0.86)	2.92* (0.43, 5.41)
Observations	61	89	88	88	68