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ΑΣΚΗΣΗ ΚΑΙ ΥΓΕΙΑ

« Multivariate analysis of surgically treated Distal Radius Fractures in the era of volar plates around Thessaly »

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Μεταπτυχιακή Διατριβή

Τριμελής επιτροπή

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Abstract

Purpose: To examine if volar plating is an efficient sole method for treatment of challenging distal radius fractures and whether AO classification has any predictive value for the preoperative planning.

Methods: Seventy nine patients with a mean age of 47,6 years (15 to 90) were treated with volar plates for distal radius fractures between 2002 and 2011. Fractures were classified according to the AO/ASIF classification (B3:25,C1:20,C2:14,C3:20). Bone graft was used in 12 patients. External fixation devices and Kirschner wires were respectively applied in 12 and 39 patients. Radial inclination and radial tilt were measured in X-rays. Grip strength, DASH and PRWHE scores were used to evaluate functional outcome. AO classification, use of external fixation and K-wires, use of grafts, DASH and PRHWE scores and radiological parameters (volar tilt, radial inclination) were analyzed statistically.

Results: At final evaluation after 5.5 years (to 11), volar tilt was 3.5° and radial inclination was 19.4°. DASH score was 6 and PRWHE score was 9.5. There was no statistically significant correlation between energy of injury & AO classification. Grip strength difference correlated with injured hand dominance. There is statistically significant correlation in the use of external fixation and metaphyseal comminution (C2,C3) in this series. K-wires use for distal radioulnar joint stability didn't differ among AO subgroups. However DASH score was worse for those with DRUJ instability. Bone graft was frequently used in C3 fractures but never in C2 fractures.

Conclusions: Volar plating may not be sufficient to maintain radius length in all metaphyseal comminuted fractures. DRUJ injury is detailed in all B3,C1,C2,C3 types thus there is the same probability for additional intervention. Graft augmentation might assist articular disimpaction in those types that specify articular comminution (B3,C1,C3).

Clinical relevance: Volar plates have become a trusty solution with overall satisfactory outcome. However metaphyseal comminution, articular comminution, and distal radioulnar instability may require additional stabilization in order to achieve optimum intraoperative anatomic reduction. AO classificasion has a prognostic value in terms of indications that may modify operative technique.

Key words: distal radius fractures, AO classification, volar plates, bone graft, optimum intraoperative reduction

Level IV retrospective case series.

Introduction

Fractures of the distal radius are one of the most common orthopedic injuries with a bimodal age distribution[1]. Frequently, these fractures are unstable with intra-articular involvement. Surgical treatment by means of open reduction and internal fixation has become popular over the last years due to better restoration of articular anatomy[2-4]. Volar plating has recently gained widespread acceptance[5-8] and tends to prevail, compared with dorsal plating, despite the variety of complications that have been reported. Potential advantages for this technique include stable subchondral fixation, early postoperative active wrist motion, restoration of articular and extra-articular alignment, and fewer complications when compared with external fixation[9]. Sometimes securing the volar tilt and intra-articular fragments with adjuvant pins is important to augment the fixation[10].

The purpose of this study is to evaluate if volar plating can be used as a sole treatment for distal radius fractures in which AO/ASIF classification suggests the use of a volar plate (B3, C1, C2, C3)

Materials and methods

Between 2002 and 2011, one hundred and nineteen patients were surgically treated for a distal radius fracture. The clinical records of surgically treated patients with a minimum follow-up of 3 years were retrospectively reviewed for demographic data, mechanism of injury, intraoperative findings (including DRUJ instability after internal fixation), X-ray evaluation (volar tilt (VT), radial inclination (RI), Grip Strength Difference (GSD), and functional scores (Disability of Arm, Shoulder and Hand-DASH), Patient Rated Wrist and Hand Evaluation-PRWHE). Criteria for participating in the study included a minimum follow up of three years and availability for an evaluation. Forty patients did not meet these criteria and were excluded from the study. Two surgeons who had not participated in any of the surgeries evaluated the remaining 79 patients. According to surgical notes all patients were treated with open reduction and volar plating of the fractures. However additional stabilization using K-wires due to DRUJ instability was used in 39 patients, graft placement in order to disimpact articular fragments in 12 and external fixation to restore radius length in 11 patients. Forty-four of the patients were men and 35 were women with a mean age of 47,6 years (range 15-90). The cause of injury was a low-energy fall in 40 patients and a high-energy accident in 39 patients. Seventy-eight were right-handed. The dominant hand was involved in 46 patients. All fractures were classified according to the AO/ASIF classification system by the first and second author. Twenty-five fractures were 23-B3, 20 fractures were 23-C1, 14 fractures were 23-C2 and 20 fractures were 23-C3. Associated injuries were present in 15 patients: 2 scaphoid fractures, 1 SLL disruption, 2 Galeazzi fracture-dislocations, 2 radial head fractures, 2 multitrauma patients, 2 metacarpal fractures, 1 scapula fracture, 1 olecranon fracture, 1 elbow dislocation, 2 rotator cuff tears.

All patients received preoperative antibiotics. Surgical procedure took place under general anesthesia or axillary block and with tourniquet control. The hand was placed on a radiolucent table in supine position in order to ensure appropriate C-arm images. A standard volar approach with a longitudinal incision over the flexor carpi radialis (FCR) was performed with the interval of dissection between FCR and radial artery. The pronator quadratus was elevated off the volar aspect of the radius from a radial to ulnar direction. The fracture site was revealed paying special attention in preservation of volar wrist capsule. Open reduction and internal fixation was performed with no prominence of the volar plate at the watershed line[11] and accurate determination of screw length. Bone graft was used in 12 patients due to articular impaction and comminution (autograft in 4 patients, allograft in 8 patients). External fixation devices and Kirschner wires were respectively applied in 11 and 39 patients for reduction and stabilization. More specifically external fixation devices were applied due to dorsal metaphyseal comminution or ulnar variance and Kirschner wires were applied due to distal radio ulnar joint instability. In the 39 patients in whom the radial shaft fracture was associated with DRUJ instability after internal fixation, temporary stabilization (4 weeks) of the reducible but unstable DRUJ was performed with a single smooth 1.2- or 1.6-mm K-wire placed transversely proximal to the sigmoid notch, with the forearm in supination. The final reduction was checked radiographically.

After surgery a volar splint was applied and digital range of motion and edema control were begun immediately. The 10th postoperative day the splint was removed and the forearm was placed in a short arm cast. Gentle active and passive wrist range of motion were initiated, with the supportive wrist control splint removed for this purpose. 6 weeks postoperatively the cast was removed and the patients started full range of motion exercises.3 months after surgery if there was radiological evidence of bone healing the patients were allowed to return to their full activities. External fixation devices and K-wires were removed after one month and six weeks respectively.

The mean follow-up was 5,5 years (3-11y). Particularly follow-up evaluations were performed at 2 weeks, 1,5 months, 3 months, 6 months and one year after surgery, though this study is based on the final follow-up visit. Assessment was performed by means of clinical evaluation and radiological examination (posteroanterior/lateral X-rays). Radial inclination, radial tilt and articular step-off were measured in X-rays. Grip strength was measured using a dynamometer (Jamar) and compared with that of the contralateral side. DASH (disabilities of the arm, shoulder and hand) and PRWHE (patient rated wrist and hand evaluation) scores were used to evaluate functional outcome. All data were collected between 6/2013 through 10/2014.

Statistical Analysis

The non-parametric Mann Whitney test was used to search for differences between variables. The non-parametric multivariate Kruskal Wallis test was used to examine for differences between groups. The non-parametric Chi-square test was used to examine for correlation between the use of K-wires, external-fixation and graft. The probability of a type-I error (alpha) was set at ≤ 0.05 for all statistical analyses.

Results

Using Mann-Whitney U Test for independent samples in this study we found out that:

- Sex has no correlation with any of the measuring the outcome parameters. More specific the distribution of Grip Strength Difference, DASH, PRWHE, RI and VT is the same across categories of sex (p_{GSD}=0.554, p_{DASH} =0.126, p_{PRWHE}=0.363, p_{RI}=0.357 and p_{VT}=0.991)

	Sex	Mean	Std. Deviation	Std. Error Mean
Grip Strength Difference (GSD)	Female	4,06	5,699	0,977
	Male	5,45	10,008	1,544
DASH	Female	5,347	5,8227	0,9986
	Male	7,910	8,0261	1,2690
PRWHE	Female	6,79	6,877	1,197
	Male	10,03	11,504	1,819
RI	Female	18,91	3,125	0,552
	Male	19,24	4,023	0,653
VT	Female	3,63	7,065	1,249
	Male	3,03	8,352	1,337

- Energy of injury has no impact on any of the measuring the outcome parameters. The distribution of Grip Strength Difference, DASH, PRWHE, RI and VT is the same across categories of type of injury (p_{GSD}=0.536, p_{DASH} =0.062, p_{PRWHE}=0.077, p_{RI}=0.086 and p_{VT}=0.443). However DASH is borderline insignificant (p=0.062) and mean DASH is worse 2 units whereas PRWHE is worse 4 units in high energy mechanism of injury.

	Type Of Injury	Mean	Std. Deviation	Std. Error Mean
Grip Strength Difference	Low energy	3,89	7,124	1,156
	High energy	5,76	9,402	1,525
DASH	Low energy	5,689	7,0733	1,1474
	High energy	7,833	7,2027	1,2004
PRWHE	Low energy	6,70	7,859	1,292
	High energy	10,47	11,188	1,865
RI	Low energy	18,71	2,976	0,503
	High energy	19,46	4,175	0,706
VT	Low energy	2,56	7,810	1,302
	High energy	4,06	7,727	1,306

- Hand dominance is only correlated with GSD (p=0.002) while DASH, PRWHE, RI and VT are the same across categories of the dominant hand (p $_{DASH}$ =0.579, p $_{PRWHE}$=0.782, p $_{RI}$=0.957 and p $_{VT}$=0.815).

	Dominant hand(dh) / non dominant hand(ndh)	Mean	Std. Deviation	Std. Error Mean
Grip Strength Difference	dh	2,64	6,912	1,030
	ndh	8,00	9,284	1,668
Dash	dh	6,535	7,1741	1,0940
	ndh	7,006	7,2714	1,3060
Prwhe	dh	7,93	8,187	1,248
	ndh	9,47	11,755	2,146
RI	dh	19,39	2,923	0,456
	ndh	18,66	4,442	0,825
VT	dh	3,22	7,512	1,173
	ndh	3,40	8,194	1,496

- AO classification preoperatively has impact on GSD and VT postoperatively whareas Dash, Prwhe and RI do not vary.
    - Grip strength differs between B3/C3 (p=0,005, Tukey's HSD). Multivariate analysis confirms that GSD statistically differs between B3/C3 (p=0,004) and additionally between B3/C1 (p=0,028).

Multiple Comparisons

Dependent Variable		(I) AO	(J) AO	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Grip Strength Difference	Tukey HSD	B3	C1	-4,557	2,405	,239	-10,88	1,77
			C2	-2,671	2,667	,749	-9,68	4,34
			C3	-8,378	2,439	,005	-14,79	-1,96
		C1	B3	4,557	2,405	,239	-1,77	10,88
			C2	1,886	2,741	,901	-5,32	9,10
			C3	-3,821	2,520	,433	-10,45	2,81
		C2	B3	2,671	2,667	,749	-4,34	9,68
			C1	-1,886	2,741	,901	-9,10	5,32
			C3	-5,707	2,771	,176	-12,99	1,58
		C3	B3	8,378	2,439	,005	1,96	14,79
			C1	3,821	2,520	,433	-2,81	10,45
			C2	5,707	2,771	,176	-1,58	12,99

Multiple Comparisons

Dependent Variable		(I) AO	(J) AO	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
VT	Tukey HSD	B3	C1	4,916	2,244	,136	-,99	10,83
			C2	6,947	2,571	,042	,17	13,72
			C3	8,197	2,277	,003	2,20	14,20
		C1	B3	-4,916	2,244	,136	-10,83	,99
			C2	2,031	2,642	,868	-4,93	8,99
			C3	3,281	2,356	,509	-2,93	9,49
		C2	B3	-6,947	2,571	,042	-13,72	-,17
			C1	-2,031	2,642	,868	-8,99	4,93
			C3	1,250	2,670	,966	-5,78	8,28
		C3	B3	-8,197	2,277	,003	-14,20	-2,20
			C1	-3,281	2,356	,509	-9,49	2,93
			C2	-1,250	2,670	,966	-8,28	5,78

- VT differs between B3/C3 (p=0,003, Tukey's HSD) and B3/C2 (p=0,042, Tukey's HSD), where B3 has closer to normal VT.

		Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
VT	B3	7,86	4,622	,985	5,81	9,91
	C1	2,95	7,051	1,618	-,45	6,35
	C2	,92	5,600	1,616	-2,64	4,47
	C3	-,33	10,146	2,391	-5,38	4,71
	Total	3,30	7,750	,920	1,46	5,13

- External fixation placement does not affect any of the documented variables.

Group Statistics

	EX-FIX	N	Mean	Std. Deviation	Std. Error Mean
Grip Strength Difference	No	66	5,30	7,563	,931
	Yes	10	1,70	12,401	3,922
Dash	No	64	6,969	7,4631	,9329
	Yes	10	5,220	4,9039	1,5508
Prwhe	No	63	8,75	9,987	1,258
	Yes	10	7,40	8,592	2,717
RI	No	59	19,31	3,455	,450
	Yes	11	17,91	4,392	1,324
VT	No	60	3,93	7,682	,992
	Yes	11	-,18	7,521	2,268

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Grip Strength Difference is the same across categories of EX-FIX.	Independent-Samples Mann-Whitney U Test	,356	Retain the null hypothesis.
2	The distribution of Dash is the same across categories of EX-FIX.	Independent-Samples Mann-Whitney U Test	,537	Retain the null hypothesis.
3	The distribution of Prwhe is the same across categories of EX-FIX.	Independent-Samples Mann-Whitney U Test	,657	Retain the null hypothesis.
4	The distribution of RI is the same across categories of EX-FIX.	Independent-Samples Mann-Whitney U Test	,397	Retain the null hypothesis.
5	The distribution of VT is the same across categories of EX-FIX.	Independent-Samples Mann-Whitney U Test	,084	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

- In adiition, graft placement does not affect any of the documented variables as well.

	GRAFT	Mean	Std. Deviation	Std. Error Mean
Grip Strength Difference	No	4,38	7,861	,983
	Yes	7,25	10,610	3,063
Dash	No	6,011	6,2652	,7957
	Yes	10,458	10,2630	2,9627
Prwhe	No	7,38	7,450	,954
	Yes	14,58	16,550	4,778
RI	No	19,44	3,430	,447
	Yes	17,18	4,167	1,256
VT	No	3,92	7,408	,964
	Yes	,25	8,986	2,594

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Grip Strength Difference is the same across categories of GRAFT.	Independent-Samples Mann-Whitney U Test	,633	Retain the null hypothesis.
2	The distribution of Dash is the same across categories of GRAFT.	Independent-Samples Mann-Whitney U Test	,084	Retain the null hypothesis.
3	The distribution of Prwhe is the same across categories of GRAFT.	Independent-Samples Mann-Whitney U Test	,233	Retain the null hypothesis.
4	The distribution of RI is the same across categories of GRAFT.	Independent-Samples Mann-Whitney U Test	,052	Retain the null hypothesis.
5	The distribution of VT is the same across categories of GRAFT.	Independent-Samples Mann-Whitney U Test	,221	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

- K-W stabilization for DRUJ injury is correlated only with DASH score (p=0,007). Moreover both DASH and PRWHE have 4 units better scores when DRUJ is intact. GSD, PRWHE, RI and VT are the same across categories of the dominant hand (p_{GSD} =0.346, p_{PRWHE}=0.197, p_{RI}=0.790 and p_{VT}=0.457).

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	4,822	1,143		4,218	,000	2,543	7,101
	DRUJ/ K-W	3,822	1,617	,268	2,364	,021	,599	7,045

a. Dependent Variable: Dash

Moreover using multiple linear regression analysis in this study we found out that:

- GSD is affected by:
  - *Hand dominance* (when dominand hand is operated GSD is 5Kgr less!) (p=0,004),
  - *AO classification*, in terms that C1 and C3 have significant higher GSD score compared to B3 fracture patterns (p=0,028 και 0,001 respectively)
  - *External fixation addition*, (p=0,034) which is in contrast with what we find out using Mann-Whitney U Test for independent samples.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2,644	1,187		2,229	,029	,280	5,009
	dh/ndh	5,356	1,858	,318	2,883	,005	1,654	9,057
2	(Constant)	-,898	1,716		-,523	,603	-4,319	2,524
	Dh/ndh	4,960	1,780	,294	2,786	,007	1,410	8,511
	C1 vs B3	5,009	2,305	,266	2,173	,033	,413	9,606
	C2 vs B3	2,486	2,550	,116	,975	,333	-2,599	7,571
	C3 vs B3	7,708	2,344	,403	3,288	,002	3,034	12,382
3	(Constant)	-,713	1,675		-,425	,672	-4,054	2,629
	Dh/ndh	5,115	1,738	,303	2,944	,004	1,650	8,580
	C1 vs B3	5,060	2,248	,269	2,251	,028	,577	9,544
	C2 vs B3	3,847	2,565	,180	1,500	,138	-1,269	8,962
	C3 vs B3	8,629	2,325	,451	3,712	,000	3,992	13,266
	EX-FIX	-5,641	2,608	-,230	-2,163	,034	-10,842	-,440

a. Dependent Variable: Grip Strength Difference

- Dash score is significantly inferior 3,8 units only in case of K-Wire stabilizing the DRUJ (p=0,021)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	4,822	1,143		4,218	,000	2,543	7,101
	DRUJ/ K-W	3,822	1,617	,268	2,364	,021	,599	7,045

a. Dependent Variable: Dash

- PRWHE has significant lower prices where:
    - graft is placed (p=0,008).
    - energy of injury is low (p=0,038)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	7,377	1,210		6,096	,000	4,964	9,790
	GRAFT	7,206	2,985	,275	2,414	,018	1,255	13,158
2	(Constant)	4,954	1,645		3,011	,004	1,672	8,235
	GRAFT	8,090	2,944	,309	2,748	,008	2,218	13,962
	Type Of Injury	4,620	2,182	,238	2,117	,038	,267	8,973

a. Dependent Variable: Prwhe

- RI is not correlated with any variable (not even graft which was not

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
2	(Constant)	21,183	2,342		9,043	,000	16,496	25,870
	Sex	,446	1,164	,062	,383	,703	-1,883	2,776
	Type Of Injury	-,013	1,196	-,002	-,011	,992	-2,406	2,380
	Age	-,021	,034	-,097	-,608	,545	-,088	,047
	R/L	-,766	,919	-,105	-,834	,408	-2,605	1,073
	DRUJ/ K-W	,073	,951	,010	,077	,939	-1,829	1,976
	GRAFT	-2,489	1,353	-,252	-1,839	,071	-5,196	,219
	EX-FIX	-1,415	1,310	-,143	-1,080	,285	-4,037	1,207
	C1 vs B3	-,657	1,210	-,081	-,543	,589	-3,079	1,764
	C2 vs B3	-1,392	1,408	-,146	-,988	,327	-4,209	1,426
	C3 vs B3	-,145	1,334	-,018	-,109	,914	-2,814	2,524

a. Dependent Variable: RI

clear)

- VT differs statistically between B3 and C1 (p=0,032), between B3 and C2(p=0,009), between B3 and C3 p=0,001). C subgroups don't differ however.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	7,864	1,527		5,149	,000	4,815	10,912
	C1 vs B3	-4,916	2,244	-,283	-2,191	,032	-9,395	-,438
	C2 vs B3	-6,947	2,571	-,338	-2,702	,009	-12,078	-1,815
	C3 vs B3	-8,197	2,277	-,463	-3,600	,001	-12,742	-3,652

a. Dependent Variable: VT

Finally we investigated any correlation between K-wire, External-fixation and graft placement:

- There was no correlation between K-wire and external-fixation use(p=0.780).

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,078[a]	1	,780		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	,078	1	,780		
Fisher's Exact Test				1,000	,518
Linear-by-Linear Association	,077	1	,781		
N of Valid Cases	79				

- There was no correlation between graft and external-fixation(p=0.544).

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,369[a]	1	,544		
Continuity Correction[b]	,024	1	,877		
Likelihood Ratio	,413	1	,521		
Fisher's Exact Test				1,000	,472
Linear-by-Linear Association	,364	1	,546		
N of Valid Cases	79				

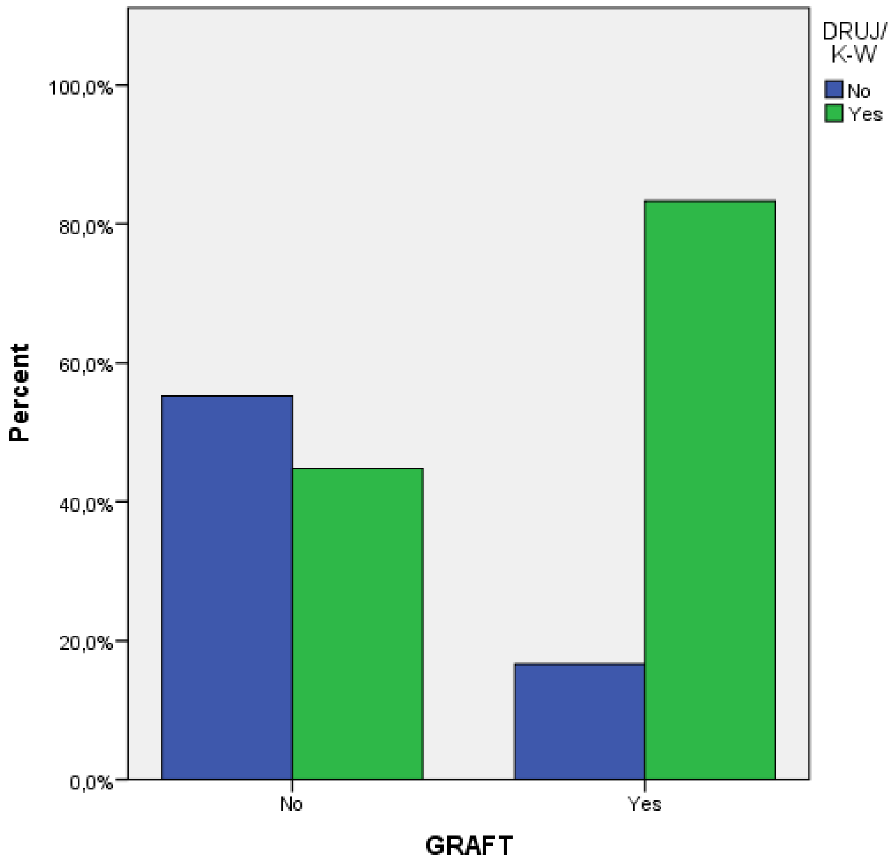
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6,053[a]	1	,014		
Continuity Correction[b]	4,609	1	,032		
Likelihood Ratio	6,542	1	,011		
Fisher's Exact Test				,025	,014
Linear-by-Linear Association	5,976	1	,014		
N of Valid Cases	79				

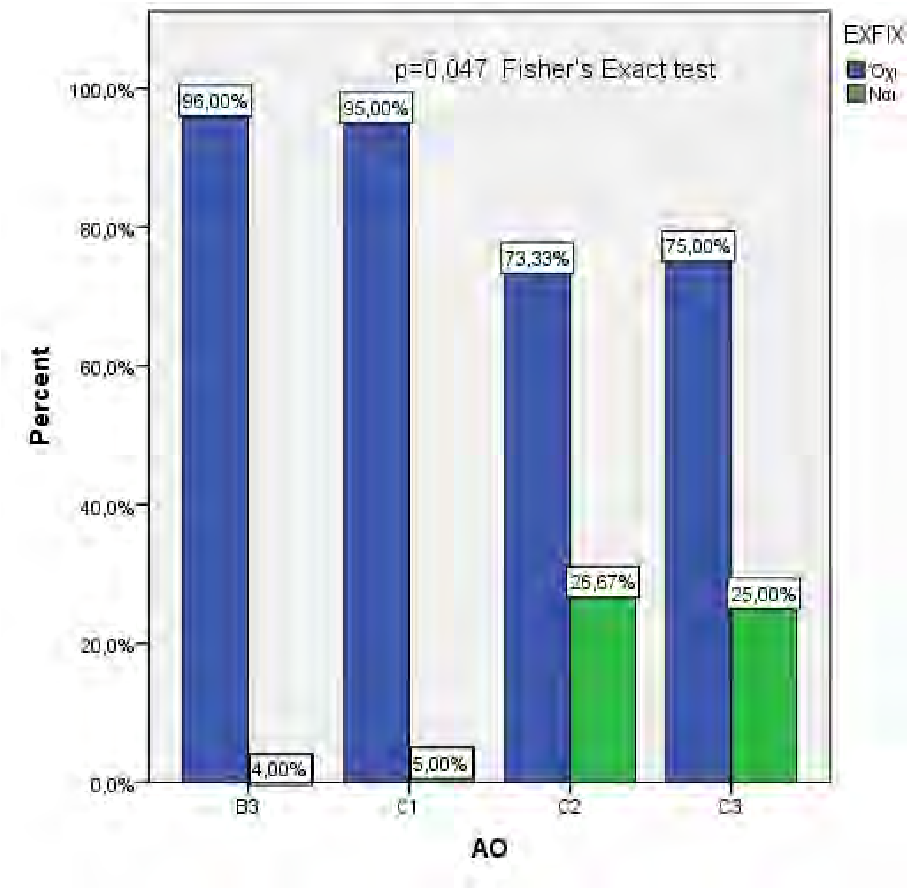
a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 5,92.

b. Computed only for a 2x2 table

- Graft placement correlates with K-wire placement (p=0.014).



- There is statistically significant correlation in the use of external fixation and metaphyseal comminution (C2 & C3) in our series(p=0.047).



- K-wires use for distal radioulnar joint stability didn't differ among AO subgroups. However DASH score was statistically higher for those with DRUJ instability.
- There is a higher use rate of graft in C3 fractures whereas graft never was used in C2 fractures.

Discussion

The optimum treatment for distal radius fractures is currently debated. Not only is the optimum type of fixation disputed, but also the decision of which fracture pattern need surgical fixation is debated. On the other hand fractures that are unstable or involve the articular surface can jeopardise the congruence and kinematics of the wrist joint. In an effort to improve clinical outcomes, surgical treatment is often recommended when there are articular incongruities of more than 1 or 2 mm after closed reduction[12, 13]. That is the reason arthroscopically assisted methods and mini materials are ushered in surgeon services[14]. In this study including AO types B3,C1,C2,C3 we emphasized in all intraoperative references of the final 79 patients included. In all cases open reduction and internal fixation using volar plate was the primary goal.

Based on the intraoperative findings additional stabilization was utilized beneficial to optimum reduction. Plate fixation alone did not always provide sufficient stability and cancellous bone graft should be added in 12 cases where articular impaction of multiple small articular fragments could not be fixed by screws[15]. The most common finding turned to be distal radioulnar joint disruption (39 cases) [16]. Temporary stabilization with K-wire of the reducible but unstable joint was performed with a single K-wire transversely placed proximal to the sigmoid notch with the forearm in supination[17]. As pointed by Johnston et al the incidence of TFCC injuries treated not acutely show worse functioning results using DASH and PHRWE scores [18]. Finally in 11 cases with metaphyseal comminution external fixation was supplementary applied[19].

As far as operative technique is concerned statistical analysis favors a statistically significant correlation in the use of external fixation and metaphyseal comminution (C2 & C3) in our series. Biomechanical studies have shown that plate alone is not sufficient for C2, C3 fractures[20, 21] as well. Multiple linear regression analysis afterall justifies adding external fixation when metaphysal comminution is the problem given the fact that the final GSD score will be better.

Bone graft was used to support disimpacted articular fragments[22] because of suboptimal articular congruency. Such cases encountered in all types (B3,C1,C3) except for C2 fractures which did not require any graft placement. Thus it is more probable to expect multifragmentary articular surface in need of disimpaction and subchondral support. In this series most cases needed graft placement were found in C3 category but that was not significant maybe cause of the small number of the cases. Another focal point is PRWHE significant lower prices where graft is placed.

K-wire for stabilization of DRUJ anatomy is crucial to the management of distal radius fractures[23] however there is not statistical preference among AO categories. Mindful of this debilitating injury intraoperative inspection is imperative no matter which is the fracture pattern. Maybe further classification to the AO subgroups of these categories analyzed here could predict this outcome. On the other hand 3.8 units worse Dash score when we use K-wire is statistically significant. Either DRUJ injury is prognostic for worse outcome or K-wire stabilization is not adequate for this kind of injury or both!

Furthermore, K-wire and graft placement is a combination of supplementary stabilization that has been outlined to have strong correlation. Based on our indications for using K-wire and graft it must be so DRUJ injury is correlated with articular comminution. No other correlation between additionally stabilizing techniques was encountered.

First prognostic outcome of this study is that volar tilt is more probable to be restored in B3 fractures rather than in those of category C where complete articular fractures exist. Second is that GSD

Contingent on the consent that a classification system should (1) be widely-adopted in the literature for research purposes, (2) describe patterns of injury with predictable outcomes, and (3) distinguish which patterns required which specific treatments as to guide surgeons; thus far, no classification system on distal radius fractures satisfies these requirements[24]. On the contrary literature is abundant with hundreds of studies formed on AO classification plus thorough knowledge and in depth preoccupation simplifies such a useful tool. In addition, there are minor prognostic factors like GSD and VT to differentiate the results between AO groups though in general the outcome is very good to excellent when anatomic congruency is achieved. Furthermore in this study there is evidence about AO classification prognostic value concerning technique. In those cases where there is indication for reconstruction with volar plate (C3, C1, C2, C3) knowing AO pattern is valid as a prognostic indicator and useful to make therapeutic decisions[25].

Metaphyseal comminuted fractures (C2, C3) advice beforehand that volar plate may not be sufficient to maintain radius length. Provided that the locking technique was correct, this type of fixation appeared efficient in maintaining the radial length in complex fractures of the distal radius[26]. Combined technique exploits the benefits of both forms of fixation, allowing each to be used to full advantage in the treatment of complex distal radius fractures[19, 27, 28]. External fixation restored radius height which correlated with grip strength as seen above[29] .

Graft augmentation might assist articular disimpaction in those categories that specify articular comminution and finally better functional outcome(PRWHE). Several investigators have demonstrated clinical success by using bone graft substitutes in conjunction with internal or external fixation for complex compression fractures[30].

Distal radioulnar joint injury is detailed in all B3, C1, C2, C3 categories thus there is the same propability for additional intervention.

Mindful of these problems, we consider that the complex fracture pattern of an unstable distal radius fracture cannot be treated by a single plate system and approach[31]. AO classification does point out metaphyseal comminution, articular comminution but does not subdivide DRUJ injuries.

Energy of injury alone cannot predict the fracture pattern according to AO classification in our series however we did not take into account other parameters like age and bone density.[32]

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