Indications for Early Surgical Intervention in Adolescents with Salter-Harris II Distal Radius Fractures

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INTRODUCTION:

Distal radius fractures involving the growth plate are an overwhelming majority of fractures in the adolescent (ages 9-18) population. While nonsurgical management is the standard of care for most distal radius fractures involving the growth plate in the pediatric population, surgical management is recommended for older patients with non-anatomic reduction due to the lack of remodeling potential with limited remaining growth. Despite this recognition, guidelines outlining optimal management strategies in the adolescent population are lacking. Non-anatomic reduction in this population can lead to a symptomatic malunion necessitating complex surgical correction with a prolonged recovery period and absence from activities. By defining the parameters for acute surgical management of adolescent distal radius fractures involving the growth plate, the potential for wrist dysfunction and further need for surgery will be prevented.

METHODS:

This was a multicenter, retrospective review of Salter Harris II (SHII) distal radius fractures in patients 9 to 18 years of age, from 2017-2020. Demographics, initial displacement, displacement post-reduction, and displacement after cast removal were evaluated. Skeletal maturity was classified using Sander's classification. These values were compared between patients who underwent casting alone, acute surgery, or required late malunion correction. Classification and Regression Tree (CART) models were also fit to identify predictors of surgical intervention.

RESULTS:

A total of 556 (76% male) SHII distal radius fractures were identified, of which 77 cases (14%) underwent surgical intervention. Sixty (78%) surgical cases were acute (median 3 days, IQR 2,8 days) and 17 (22%) cases were performed to correct late malunion (median 433 days, IQR 274, 581 days). Two patients (3%) who underwent acute surgery developed late malunion requiring correction. As shown in Table 1, the surgically treated patients tended to be older, have greater sagittal and coronal translation, less radial inclination, and more dorsal tilt following fracture reduction, and increased residual dorsal tilt post-reduction is found in the late malunion correction group. A CART model correctly classified 92% of acute surgery patients with 39% sensitivity and 93% specificity utilizing all variables. A secondary CART model excluding sex and age at injury performed similarly (classification 92%, sensitivity 39%, and specificity 93%). Both models (Figures 1&2), determined that sagittal translation post reduction (<35 vs. >= 35) had the greatest discriminative power. Age at injury (Age ≥12), in the first model, and Sander's classification (Class > 3), in the second model, further aided in determining who underwent acute surgery.

DISCUSSION AND CONCLUSION:

In SHII distal radius fractures, persistent dorsal angulation after reduction, intermediate age, and persistent sagittal translation after reduction are associated with late malunion. Skeletal maturity utilizing Sander's classification was not associated with malunion. Increased magnitude of deformity in all planes following closed reduction and casting was associated with acute surgery. Treatment guidelines for acute surgical intervention of this fracture type based on defined parameters of deformity and age are limited and this study is among the first to describe a treatment protocol (Figures 1&2) to this degree of specificity. Following these treatment guidelines will avoid undertreatment which can lead to the need for complex surgical correction of the malunion.

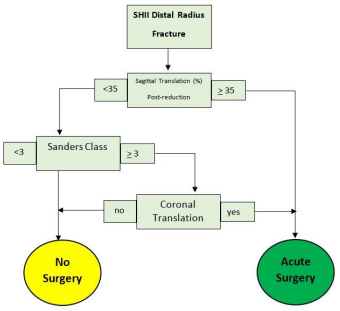

Figure 1. SHII Distal Radius Fracture CART Model – Sex and age at injury excluded
(Sensitivity 37%, specificity 93%, misclassification 8%)

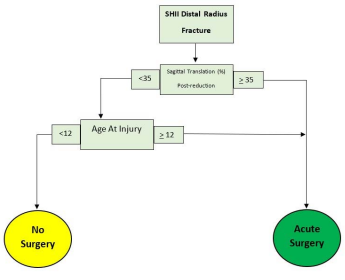

Figure 2. SHII Distal Radius Fracture CART model – all factors
(Sensitivity 39%, specificity 93%, misclassification 8%)

Variable	*No surgery (n=479)*	*Acute surgery only (n=60)*	*No surgery vs. acute*	*Malunion surgery (n=17)*	*No surgery vs. malunion*
	N (column %)	N (column %)	p[1]	N (column %)	p[1]
Female	115 (24%)	16 (27%)	0.753	3 (18%)	0.587
Male	364 (76%)	44 (73%)		14 (82%)	
	Median (IQR)	Median (IQR)	p[2]	Median (IQR)	p[2]
Age at injury	12.6 (11, 14.2)	13.8 (12.5, 14.9)	**<0.001**	13.7 (12.6, 14.2)	**0.034**
Days, injury to reduction	0 (0, 0)	0 (0, 1)	0.037	0 (0, 0.5)	0.643
Sanders classification	4 (3, 5)	5 (4, 7)	**<0.001**	3 (3, 4.5)	0.630
Post-reduction measurements					
Coronal translation %	0 (0, 3.9)	11.6 (0.3, 18.3)	**<0.001**	0 (0, 12)	0.340
Sagittal translation %	8 (0, 17.3)	30 (11.6, 37.9)	**<0.001**	22.5 (0, 30)	0.095
Radial height	9.1 (7.5, 11)	8.4 (6.4, 10.8)	0.056	9 (7.8, 11)	0.990
Radial inclination	18.1 (15.7, 21.1)	16.6 (12.1, 20.2)	**0.012**	17 (14, 18.3)	**0.023**
Tilt % in volar direction	0 (0, 6.6)	0 (0, 5.2)	0.259	0 (0, 0)	0.102
Tilt % in dorsal direction	0 (0, 7.2)	5.2 (0, 16.6)	**<0.001**	9 (0, 16)	**0.025**

[1] Permutation test p-value. [2] Brunner-Munzel (generalized Wilcoxon) test p-value.