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

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Introduction

- Distal radius fractures are very common in the pediatric patient, fifteen percent of which involve the physis, where Salter-Harris II (SHII) fractures are predominant.
- Currently, there is a lack of information regarding risk factors for failure of nonoperative treatment in this population. Information accounting for developmental age and skeletal maturity is lacking as well.
- Our purpose is to identify predictors of which patients will require acute surgery and which will develop late malunion based on degree of deformity and skeletal maturity.

Methods

- This was a retrospective review of SHII distal radius fractures in patients 9 to 18 years of age, from 2017 to 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, underwent acute surgery, or required late malunion correction.
- Classification and Regression Tree (CART) models were also fit to identify predictors of surgical intervention.

Results

- 271 (30% female) SHII distal radius fractures were identified
- Of which, 34 cases (13%) underwent surgical intervention with CRPP or ORIF.
- Twenty-two (65%) surgical cases were acute (median 9.5 days, IQR 3.2-14 days) and
- Twelve (35%) cases were performed to correct late malunion (median 459.5 days, IQR 325.5-542 days).
- No patients who underwent acute surgery developed malunion.
- As shown in Table 1, the late malunion group tended to be older, have greater tilt in dorsal direction post-reduction and post-cast removal, and have greater post-reduction sagittal translation compared to the casting group.
- A CART model (Figure 1) correctly classified 94% of acute surgery patients with 55% sensitivity and 97% specificity. A second CART model (not shown) identified greater degree of dorsal tilt post-cast removal as the strongest predictor of malunion (misclassification 4%, sensitivity 42%, specificity 97%).

Variable	Cast-only (n=237)	Acute surgery (n=22)	Cast-only vs. acute	Malunion surgery (n=12)	Cast-only vs. malunion
Categorical Variables	N (column %)	N (column %)	p[1]	N (column %)	p[1]
Female	71 (30%)	6 (27%)	0.816	3 (25%)	0.764
Quantitative Variables	Median (IQR) [min-max]	Median (IQR) [min-max]	p[2]	Median (IQR) [min-max]	p[2]
Age at Injury	12.2 (10.7, 14) [9.1, 17.9]	14.6 (14.2, 15.5) [12, 17.9]	<0.001	13.7 (12.5, 14.5) [10.5, 16.7]	**0.038**
Sander's class	3 (3, 5) [1, 7]	6 (4.2, 7) [3, 8]	<0.001	3 (3, 5) [3, 7]	0.461
Initial Measurements					
Sagittal translation	40 (27, 60) [0, 100]	63.5 (51, 90) [24, 100]	<0.001	42.5 (34.2, 66) [21, 100]	0.406
Radial Height	6 (2, 8) [-20, 15]	3.5 (0, 6) [-5, 9]	0.003	7 (0.8, 8.2) [-16, 10]	0.796
Radial Inclination	14 (6, 19) [-28, 161]	8 (0, 13) [-10, 16]	<0.001	14.5 (3, 19.8) [-15, 24]	0.777
Tilt % in volar direction	0 (0, 0) [0, 29]	0 (0, 6) [0, 21]	0.692	0 (0, 0) [0, 13]	0.081
Tilt % in dorsal direction	17 (0, 26) [0, 53]	19.5 (2.2, 34.2) [0, 42]	0.325	25 (19.8, 28) [0, 34]	**0.028**
Post-reduction measurements					
Coronal translation %	0 (0, 0) [0, 36]	13 (0, 24.5) [0, 61]	<0.001	0 (0, 11.2) [0, 22]	0.225
Sagittal translation %	0 (0, 14.5) [0, 61]	30 (5.2, 39.2) [0, 100]	<0.001	18 (0, 27.2) [0, 41]	0.084
Tilt % in dorsal direction	0 (0, 7) [0, 33]	7.5 (0, 16) [0, 41]	0.025	7.2 (0, 12.2) [0, 35]	0.088
Post-cast removal measurements					
Coronal translation %	0 (0, 0) [0, 36]	0 (0, 17) [0, 61]	0.044	0 (0, 0) [0, 19]	0.509
Sagittal translation %	0 (0, 11) [0, 54]	28 (14, 38) [0, 100]	<0.001	14 (0, 38) [0, 58]	0.104
Tilt % in dorsal direction	0 (0, 9.2) [0, 30]	0 (0, 13) [0, 41]	0.448	19 (0, 22.5) [0, 25]	**0.040**

Table 1

References

Figure 1: Salter Harris II Distal Radius Classification and Regression Tree
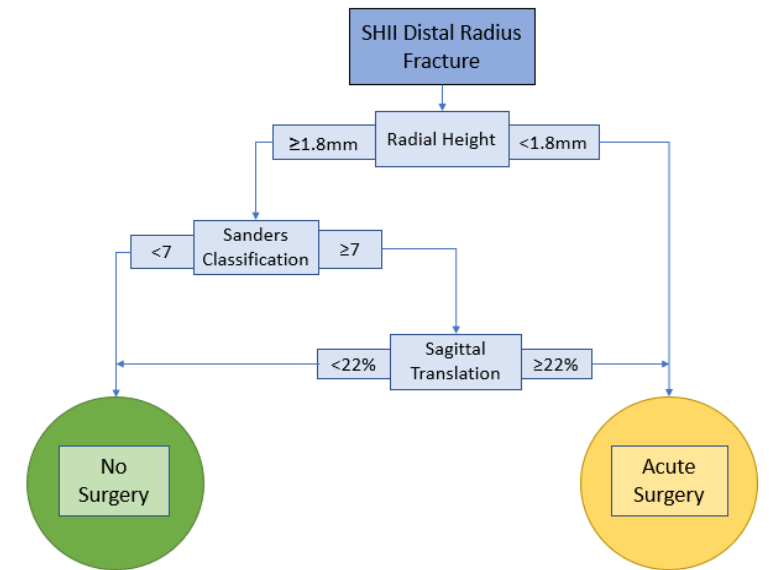
Conclusion and Significance

- This is the largest cohort of SHII distal radius fractures to date. Persistent dorsal angulation after reduction and post-casting were 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 as was higher Sander's class.
- Treatment guidelines for acute surgical intervention of this fracture type based on skeletal maturity are limited and this study is among the first to describe treatment that considers skeletal maturity. The cutoff values for degree of deformity and skeletal maturity can be used predict need for acute surgery as shown in the CART model.