Outcomes of Completely Displaced and Rotated Lateral Humeral Condyle Fractures in Children: A Multicenter Study

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INTRODUCTION:

Song V lateral humeral condyle fractures represent a displaced and rotated fragment, historically treated with open reduction and percutaneous pinning (ORPP) or screw fixation (ORSF) with some recent studies reporting the success of closed reduction and percutaneous pinning (CRPP) or screw fixation (CRSF). We aim to describe outcomes of these displaced and rotated fractures and analyze the effect of fixation and type of reduction on outcomes.

METHODS: This retrospective review assessed data from six level 1 trauma centers from 2005 to 2019. Inclusion criteria were children aged 1-12 with a Song V graded fracture. Patient clinic and surgical notes until one year after the primary intervention were reviewed. Complication metrics included nonunion, delayed union, elbow stiffness, and superficial or deep infection. Time to K-wire or screw removal was collected. Data collection was coordinated across the six centers.

RESULTS: 281 lateral humeral condyle fractures from the six centers were classified as Song V. Mean age was 8.8 years, and 65.1% were male. K-wires were used in 223 patients (79.4%) and screws in 58 patients (20.6%). Six patients (2.1%) experienced a superficial infection, and six patients (2.1%) experienced a deep infection. Five patients experienced nonunion (1.8%). K-wires were used in 223 patients (79%) and screws in 58 (21%) patients. For patients undergoing an ORSF, 81% were radiographically healed at 3 months, while 78% of patients undergoing an ORPP were radiographically healed at 3 months. No differences were observed between the type of hardware and outcome measures such as nonunion, stiffness, and infection, but all 12 infections occurred in the K-wire group. Open reduction was utilized in 268 (95.4%) patients, compared to closed reduction in 13 (4.6%) patients. No statistically significant relationships were seen between reduction type and complications. Trends were observed suggesting increased rates of infection and elbow stiffness for ORPP and those undergoing open reduction.

DISCUSSION AND CONCLUSION:

In the largest analysis of Song V lateral humeral condyle fractures, outcomes were comparable between ORSF and ORPP, with similar rates of radiographic healing, nonunion, and stiffness, while trends showed increased infection rates for ORPP. Our findings also suggest closed reduction may be a non-inferior method to open reduction. However, as open reduction is the widely preferred approach, there was a large sample size disparity between the open and closed reduction groups, and further research is necessary to better understand these trends.

Table 1. Patient Demographics, N=281

Age at presentation [mean (SD)]	8.81 (3.38)
Male Sex, n (%)	183 (65.1%)
Weight in kg [mean (SD)]	24.81 (10.78)
Type of Reduction	
Open, n (%)	268 (95.4%)
Closed, n (%)	13 (4.6%)
Type of Fixation	
K-wire, n (%)	223 (79.4%)
Screw, n (%)	58 (20.6%)
Milch, n (%)*	
I	38 (13.5%)
II	239 (85.1%)
Jacob, n (%)	
II	5 (1.8%)
III	276 (98.2%)
Elbow instability, n (%)	83 (29.5%)
Duration of Casting in Weeks [mean (SD)]	5.22 (1.58)

*Of all Song V patients, 5 patients missing sex data

*Of all Song V patients, 4 patients missing Milch data

Table 2. Song V Patient Outcomes, N=281

Superficial Infection, n (%)	6 (2.1%)
Deep infection, n (%)	6 (2.1%)
Skin irritation due to Casting, n (%)	1 (0.4%)
Pain, n (%)	2 (0.7%)
Skin irritation due to hardware, n (%)	0 (0.0%)
Overall stiffness, n (%)	64 (22.8%)
Stiffness requiring surgery, n (%)	2 (0.7%)
Osteonecrosis, n (%)	4 (1.4%)
Delayed healing, n (%)	115 (40.9%)

Table 3. Closed Reduction Characteristics and Outcomes

	Closed Reduction		
Parameters, n (%)	Screw, N=3	K-wire, N=10	P-value
Age in years, mean (SD)	8.0 (1.0)	7.8 (1.0)	0.895
Sex			0.279
Male	3 (100)	7 (70)	
Female	0 (0)	3 (30)	
Duration of casting in weeks, mean (SD)	5.0	6.4 (1.8)	0.473
Elbow instability	0 (0)	2 (20)	0.400
Nonunion	0 (0)	0 (0)	-
Stiffness	0 (0)	1 (10)	0.569
Stiffness surgery	0 (0)	1 (10)	
Stiffness physical therapy	0 (0)	0 (0)	
Osteonecrosis	0 (0)	1 (10)	0.569
Superficial Infection	0 (0)	0 (0)	-
Deep Infection	0 (0)	0 (0)	-
Pain	0 (0)	0 (0)	-
Hardware Removal	0 (0)	0 (0)	-

Significant P values are **bolded**

SD, Standard deviation

Table 4. Open Reduction Characteristics and Outcomes

	Open Reduction		
Parameters, n (%)	Screw, N=55	K-wire, N=213	P-value
Age in years, mean (SD)	7.4 (3.2)	9.2 (3.4)	**<0.001**
Sex			0.893
Male	37 (67)	136 (64)	
Female	17 (31)	73 (34)	
Duration of casting in weeks, median (IQR)	4.8 (1.9)	5.3 (1.5)	0.062
Elbow instability	23 (42)	58 (27)	**0.036**
Nonunion	0 (0)	5 (2)	0.251
Stiffness	11 (20)	52 (24)	0.491
Stiffness managed by surgery	1 (2)	1 (0.4)	
Stiffness by physical therapy	10 (18)	51 (24)	
Osteonecrosis	0 (0)	3 (1)	0.376
Superficial Infection	0 (0)	6 (3)	0.208
Deep Infection	0 (0)	6 (3)	0.208
Pain	1 (2)	1 (0.4)	0.300
Hardware Removal	2 (4)	5 (2)	0.593

Significant P values are **bolded**

SD, Standard deviation

IQR, Interquartile range

Table 5. Radiographic Data

	Open Reduction		
	Screw, n (%)	K-wire, n (%)	P-value
Radiographic Healing			0.421
6 weeks	18 (33)	86 (40)	
3 months	19 (35)	56 (26)	
6 months	10 (18)	28 (13)	
12 months	0 (0)	4 (2)	
	Closed Reduction		
	Screw, n (%)	K-wire, n (%)	P-value
Radiographic Healing			0.738
6 weeks	1 (33)	3 (30)	
3 months	0	0	
6 months	0	2 (20)	
12 months	0	1 (10)	

Significant P values are **bolded**