BIOMECHANICAL ANALYSIS OF CROSSED PINNING CONSTRUCT IN SUPRACONDYLAR FRACTURE OF HUMERUS IN CHILDREN: DOES POINT OF CROSSING MATTERS?

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INTRODUCTION:

Closed reduction and percutaneous pin fixation either by crossed pinning construct (CPC) or lateral divergent pinning construct (LDPC) are the recommended treatment for displaced (Gartland type 2 & 3) supracondylar humerus fractures (SCHF) in children. Many studies have compared the biomechanical stability between these two. A biomechanical analysis of varying crossing point location in CPC has not been performed previously. The main objective of this study is to compare the stability of various crossing point location in crossed K-wiring construct in treatment of SCHF in children. The other objective is to compare the stability between CPC and LDPC in the treatment of SCHF in children.

METHODS:

Thirty synthetic humeri were osteotomized simulating the SCHF. Specimens were all anatomically reduced and pinned using two 1.6 mm Kirschner wires (K-wires) in five different constructs namely centre point CPC, medial point CPC, lateral point CPC, superior point CPC and LDPC. Six samples were prepared for each construct and were tested for linear forces (extension, flexion, valgus, varus) and rotational forces (internal rotation and external rotation). Data for fragment stiffness (N/mm or Nmm/degree) were analysed and a level of $P<0.05$ was considered statistically significant.

Figure 1: linear force testing

Figure 2: rotational force testing

RESULTS:

The centre point CPC was the stiffest for both linear and rotational force but Lateral point CPC, and Superior point CPC showed no statistically significant stability difference when compared to the stiffest construct (centre point CPC). Lateral divergence construct showed no statistically significance rotatory instability, but showed significant linear instability when compared to centre point CPC.

Table 1: Stiffness between construct for linear force

Type of construct	Mean	Median Stiffness (IQR)	Test statistic*	P-Value
Centre	48.6960	44.10(36.40,56.78)	Baseline	Baseline
Medial	47.6235	41.83(29.45,59.10)	239	0.3013
Superior	43.5952	42.88(27.77,56.49)	255	0.1404
Lateral	41.3335	38.74(34.22,45.30)	243	0.2534
Divergence	38.7175	30.15(27.30,42.58)	321	0.0007474**

* Wilcoxon signed -rank test (Comparing with Centre). **p<0.05

Table 2: Stiffness between construct for rotational force

Type of construct	Mean stiffness	Median Stiffness (IQR)	Test statistic*	P-Value
Centre	0.385	0.40(0.40,0.40)	Baseline	Baseline
Lateral	0.380	0.40(0.35,0.40)	57	0.5602
Divergence	0.380	0.38(0.35,0.40)	61	0.3571
Superior	0.380	0.38(0.35,0.40)	61	0.3571
Medial	0.265	0.25(0.25,0.30)	99	0.0001351**

* Wilcoxon signed-rank test (Comparing with Centre). **p<0.05

DISCUSSION AND CONCLUSION:

The Centre point CPC was proved to be the stiffest construct. However, the stability of lateral point CPC and superior point CPC were comparable and showed no statistically significant difference when compare to Centre point CPC. If crossed pinning construct was chosen as method of treatment, the treating surgeons do not necessarily have to revise the crossed wire fixation in order to get perfect centre crossing point fixation. This will eventually reduce the numbers of attempt during K-wire insertion and reduce the possible complications associated with multiple attempt procedures.

REFERENCES:

1. Hamdi, A., Poitras, P., Louati, H., Dagenais, S., Masquijo, J. J., & Kontio, K. (2010). Biomechanical analysis of lateral pin placements for pediatric supracondylar humerus fractures. Journal of Pediatric Orthopedics, 30(2), 135-139.