PROXIMAL CARPAL ROW RESECTION: AN IN VITRO STUDY OF IMPACT ON KINEMATICS, MOMENT ARMS AND JOINT LOADS

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INTRODUCTION

Resection of the proximal carpal row is indicated for scapho-lunate advanced collapse (SLAC), scaphoid non-union advanced collapse (SNAC), or scaphoid chondrocalcinosis advanced collapse (SCAC), irreducible perilunate dislocation, and carpal necrosis [1]. We conducted an experimental study in anatomical specimens to determine the biomechanical consequences of this resection, focusing on wrist kinematics, the moment arm of six wrist muscles (ECRB = extensor carpi radialis brevis, ECRL = extensor carpi radialis, ECU = extensor carpi ulnaris, APL = abductor pollicis longus, FCR = flexor carpi radialis, and FCU = flexor carpi ulnaris) and the constraint applied to the distal radial epiphysis.

METHODS

Five fresh-frozen human upper limbs were obtained from the ULB donation program. Each of these was radiographically normal. Fishing wires were attached to the distal tendons of the six wrist muscles for loading (20 N for each tendon). The specimens were set on a customized jig to stabilize the humerus, radius and ulna in semi-pronated position (Figure 1). Measurements were made on the intact wrist, after posterior capsulotomy and after resection of the proximal row. A 6 DOF-electrogoniometer was used for kinematic recordings [2]. Six linear displacement sensors (LVDT) were used to study the muscle moment arms using the tendon excursion method [3]. The constraint applied to the distal radial epiphysis was measured using two strain gages (SG) that were introduced underneath the lunate (SG2) and scaphoid (SG1) fossae of the radius [4].

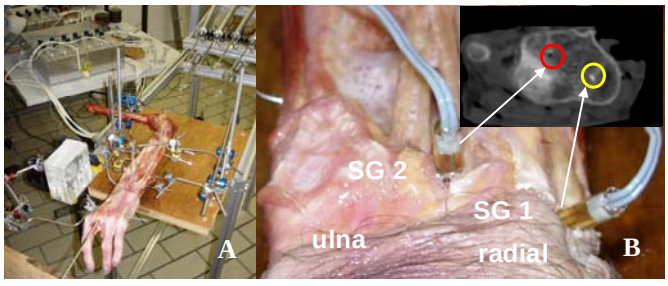

Figure 1: (A) Experimental setup showing the electrogoniometer and LVDT installation.(B) Strain gages (SG) placement in the radius.

Two way Anova were used to compare the repeated measurements in each condition (intact – capsulotomy – resection).

RESULTS AND DISCUSSION

Capsulotomy had no significant effect on the measurements made. As expected, after proximal row resection, there was a significant proximal displacement of the pivot point during dorsopalmar flexion (7 mm), radioulnar deviation (9 mm), and circumduction (7.5 mm). There was no significant difference in joint range of motion. The mean moment arms of the muscles decreased significantly ($p<0.001$), except for APL during dorsopalmar flexion and FCU during radioulnar deviation (table 1). Analysis of the instantaneous moment arms demonstrated that the movements that were most affected by the resection were radial deviation and dorsal flexion. Stress forces on the distal radial epiphysis (lunate and scaphoid fossae) also varied significantly. Little work has been published on this subject. Evaluation of joint range of motion does not reflect the reality since it is measured for plane movement against resistance.

	APL	ECRB	ECRL	FCU	FCR	ECU
			Dorsopalmar flexion			
Intact	7,4(1,7)	8,9(2,9)	3,6(0,8)	12,4(1,0)	15,8(2,6)	10,0(2,3)
Caps	7,1(2,3)	8,8(3,6)	3,4(1,0)	13,2(1,2)	16,1(2,2)	10,9(3,5)
Resec	7,7(1,1)	4,6(4,1)	2,3(2,4)	10,4(1,3)	11,5(3,1)	8,9(4,0)
			Radioulnar deviation			
Intact	27,8(0,6)	13,3(1,7)	19,3(2,0)	16,9(2,4)	5,5(1,3)	22,8(1,3)
Caps	28,0(1,4)	13,4(1,6)	20,0(2,1)	16,5(2,5)	6,1(1,7)	23,4(1,8)
Resec	15,5(2,0)	6,7(5,1)	8,8(8,4)	16,9(2,6)	2,6(2,6)	11,9(13,7)

Table 1: Mean muscles moment arms during dorsopalmar flexion and radioulnar deviation (SD) in mm

Displacement of the pivot point is greatest during radioulnar deviation. APL and ECU are the main stabilisers of the normal wrist, particularly during dorsopalmar flexion. Dynamic stability would thus be preserved after proximal row resection.

CONCLUSIONS

Resection of the proximal carpal row significantly affects wrist biomechanics, in terms of pivot point, muscle moment arms, and distal radial constraints.

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