AN INVESTIGATION OF WRIST JOINT FUNCTION UNDER LOAD

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INTRODUCTION

Previous studies of the wrist joint have considered both individual carpal bone motion and the gross kinematics of the entire wrist complex. A variety of different grip tools have also previously been used to measure loading of the wrist joint during whole hand gripping tasks. Few of these studies however, captured kinematic data in conjunction with kinetic measurements and there is a lack of fully three-dimensional loading data. As a result there is disagreement in the literature, both about the definition of the 'functional neutral' position of the wrist and about the kinematic 'envelope' inside which the hand can provide its maximal gripping force [1].

The aim of the current study was to investigate if the 'functional neutral' position of the wrist joint coincided with the 'anatomical neutral' position in relation to generating the maximal gripping force. The active operating ranges of the wrist during maximal gripping force were also examined.

METHODS

Fifty right-hand dominant adults (25 males, 25 females), with no history of hand trauma participated in the study. The subjects were required to generate maximal gripping force in five different wrist positions: neutral, flexion, extension, radial and ulnar deviation. An eight camera, 120Hz VICON (Oxford Metrics) motion analysis system and a custom-built grip strength tool containing five six-component force transducers were used to obtain concurrent three-dimensional kinetic and kinematic data for each digital segment, the metacarpals, wrist and forearm. Subjects were asked to provide their maximal gripping force in maximal functional positions of wrist flexion, extension, radial and ulnar deviation. For the functional neutral wrist position, subjects adopted a self-defined position of optimal function around the anatomical neutral position.

RESULTS AND DISCUSSION

The functional neutral position of the wrist was experimentally defined as slight extension of the joint, with a mean of 33 degrees extension (SD 17.6) in 94% of the subjects (Table 1). This wrist extension was coupled with a mean of 8 degrees of ulnar deviation (SD 10.1) and it was the position in which the subjects provided their maximal resultant gripping force (Fig.1). In extension, radial deviation and ulnar deviation of the wrist the subjects generated similar

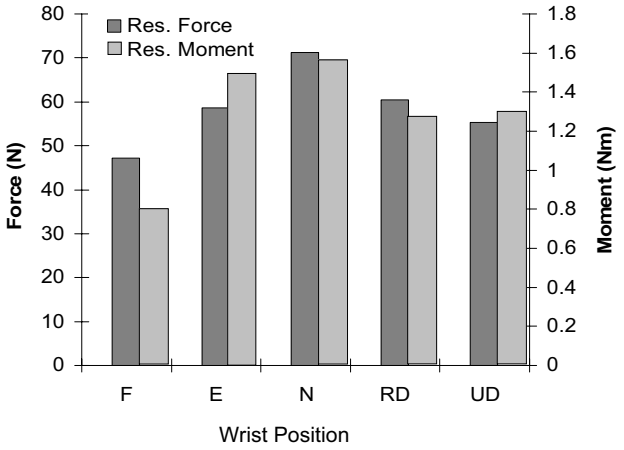

Figure 1: The resultant forces and moments applied to the thumb in flexion (F), extension (E), radial (RD) and ulnar deviation (UD) of the wrist.

maximal resultant forces, whilst in flexion the applied forces were significantly lower. The largest values of the resultant moments were in the neutral and extended positions and the lowest values were obtained for the flexed wrist (Fig.1). For each intended wrist joint position there was a coupling of motion in other planes. Joint flexion was combined with radial deviation, extension with ulnar deviation, radial deviation with extension and ulnar deviation with flexion (Table 1). Previous studies have observed similar coupling patterns during unloaded radial and ulnar deviation but show free wrist flexion coupled with ulnar deviation [2]. This discrepancy may reveal altered kinematic patterns as the wrist is loaded.

CONCLUSIONS

The optimum joint position for production of maximal grip force was a slightly extended and ulnar deviated wrist. This kinematic coupling of flexion-extension with radio-ulnar deviation, together with the definition of the functional neutral wrist position are important characteristics of wrist function under load.

REFERENCES

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Table 1: Mean wrist angles in each functional position.

Intended Wrist Position	**Mean (SD) (degrees)**		**Mean (SD) (degrees)**
Neutral [flexion (+)-extension(-)]	-33 (17.6)	Combined Ulnar Deviation	8 (10.1)
Flexion	59 (15.5)	Combined Radial Deviation	14 (10.4)
Extension	53 (13.4)	Combined Ulnar Deviation	12 (9.0)
Radial Deviation	13 (8.1)	Combined Extension	12 (15.2)
Ulnar Deviation	25.8 (11.4)	Combined Flexion	8.9 (28.4)