THREE DIMENSIONAL IN-VIVO KINEMATIC ANALYSIS OF THE DISTAL RADIOULNAR JOINT DURING RESISTED ACTIVE MOTION

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ABSTRACT

INTRODUCTION

There has not been any study that has analyzed the kinematics of the distal radioulnar joint (DRUJ) during resisted active motion. It is thus not known how much relative displacement, if any, occurs at the DRUJ during such motions. This study is an in-vivo kinematic investigation using 3D computer tomographic (CT) scans of the DRUJ with normal volunteers performing resisted active pronation and supination with the hand maintained in neutral position. Subsequent 3D analysis of the image data is then performed to provide preliminary information of the kinematics of the DRUJ during such motions.

METHODS

After obtaining approval from our institutional review board, ten healthy, normal volunteers were recruited and consented. Physician review, examination, and radiographs were performed of their upper limbs to exclude any pathology. Three dimensional CT scans (General Electric Medical Systems, Lightspeed Ultra, 8 detector CT scanner, voxel size 0.2929692 x 0.600001 mm3) were performed of the distal forearm of these volunteers, while grasping the vertical/neutral post of a custom made jig with their hands to keep the plane of the fist/hand in the neutral position (Fig 1). Scanning was performed in three positions: neutral position (taken as the control position), resisted active supination against the neutral post, and resisted active pronation against the neutral post. The volunteers were instructed to perform the resisted active motions at maximum effort. Analyze 6.1 program was used to perform thresholding, segmentation and registration of the image data. Comparisons of image data was performed between neutral and resisted active pronation (NeutPron), neutral and resisted active supination (NeutSup), and resisted active supination and resisted active pronation (SupPron). Separate three-dimensional surface registrations were performed for the distal ulna bones (M3) and distal radius bones (M4) respectively. The eventual 4x4 transformation matrices were processed using a custom Matlab program to derive the magnitude of vector displacements based on the centre of the volume images using the ulna transformation matrix as the base (M3/M4). Means comparison with Student’s t test in JMP 5.1.2 was used.

RESULTS

The overall mean three dimensional volume image displacement was 6.54 mm (SD 1.84 mm) when compared from the neutral position to maximum resisted active pronation (Neut_Pron). It was 6.87 mm (SD 3.56 mm) when compared from neutral to maximum resisted supination (Neut_Sup). The displacements between Neut_Pron and Neut_Sup were statistically similar. However, when Neut_Pron or Neut_Sup were compared to Sup_Pron, the results were statistically different (p < 0.05) (See Chart 1). The mean difference in displacement during maximum resisted active pronation between the left and right side was 0.04 mm (SD 0.54 mm). The mean difference in displacement during maximum resisted active supination between left and right side was 1.56 mm (SD 1.71 mm). These differences in relative displacements between the left and the right upper limbs were not statistically significant (See Chart 2). Unlike in active pronation and supination, where the ulnar head slides/rolls from the dorsal rim of the sigmoid notch to the volar rim, in resisted active pronation or supination, the ulnar head remains largely in proximity to the dorsal rim (See Fig 2).

DISCUSSION

Despite the hand maintaining a static neutral position, significant three dimensional displacements were produced in the distal radius and distal ulna sufficient to produce centre of image displacements. As expected, displacements were significantly larger for maximum resisted supination to maximum resisted pronation when compared to maximum resisted pronation or supination to neutral. Similar motions of the left and right side did not reveal significant differences. This information may be useful when determining the presence of unilateral DRUJ pathologies. The methodology used in this study can be used as a foundation for development of further kinematic study of the DRUJ.

REFERENCES


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