Modelling of the Wrist Bones

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Introduction

Biomechanics examines effects of forces acting on anatomical systems using the theory of mechanics. The wrist is recognised as one of the most complex joints in the body, and is less well understood than other joints [1]. It contains eight bones arranged in two lateral rows. Nearest the forearm is the distal row, containing; scaphoid, lunate, triquetrum and pisiform. Between the distal row and hand is the proximal row of; trapezium, trapezoid, capitate and hamate. Numerous ligaments connect between bones and the wrist has four defined movements; flexion, extension, abduction and adduction.

Project objectives were to create a model which could measure relative bone displacement during wrist movement. Wrist of different anatomies would be studied and forces applied to see if bone size and shape affects this.

Methods

Three CT scans were used as a background images To generate three-dimensional models from images, Simpleware technology was used. Masks were applied matching the surface features of each bone using ScanIP, the image processing tool within the software. Many approaches were required to find a method that would give a model of sufficient accuracy and quality.

Three models were created representing the radius, scaphoid and lunate, and a full wrist model was made for one of the samples.

Methods to export the model to SolidWorks were then explored. This software would be used to model ligaments and use motion simulation to apply movement.

Further to this a module called +CAD within Simpleware was used to create a CAD model of which was then prepared for 3D printing.

Results

Three models consisting of the radius, scaphoid and lunate were obtained, and one which showed all bones of the wrist. Surface features were obtained and the bones shown in their correct positions. Data on the bones was obtained; including volume and surface area. Capitate was found to be the largest bone by volume and 330% greater than the smallest which was the pisiform.

Discussion

An effective way of creating a model from CT scans was found, acting as a basis for further work. Approaches that were less successful were identified and could be avoided. The creation of a model was found to be technically challenging and required more time than was estimated at the beginning of the Project.

More research was required before ligaments could be created and a motion study carried out. The experiments would have rotated around the head of the capitate (C), would have caused rotation R and displacement S on other bones.

Despite the difficulty, measuring relative bone movement is technically feasible. With better CT scan data, and using software programming to create relationships between the bones and ligaments. Work should be split into three areas, an anatomist, a CAD modeller and a programmer.

References