METHOD TO DETERMINE BONES RELATIVE DISPLACEMENTS USING A CT SCAN: APPLICATION TO SCAPHOID AND LUNATE BONES

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Introduction

Lesions in the wrist may occur during a major injury (roller skating, winter sports accidents). Ligament rupture is the cause of chronic instability leading to the progression of osteoarthritis. Knowledge of the kinematics of the carpus in normal conditions can help for the treatment of this type of pathologies.

3D carpal kinematics has been described using measurement techniques such as CT [Crisco, 1999; Moojen, 2002]. Kinematic accuracy methods have been evaluated [Neu, 2000]. The paper presents a method to determine, in vivo, the relative displacement between scaphoid and lunate and to estimate uncertainties of the displacement parameters (figure 1).

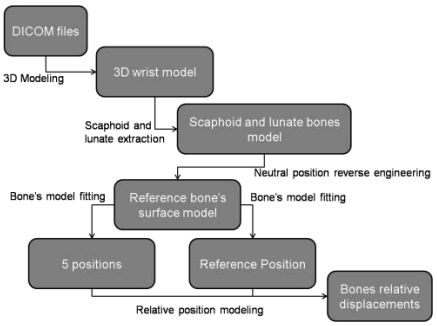

Figure 1: Relative displacement measurement flowchart method.

Methods

The study was conducted on a healthy volunteer with a CT scan. Different positions of the wrist were studied: extension, flexion, ulnar and radial deviations and neutral profile. The reference position was the neutral pronation. From DICOM files, a reconstruction of scaphoid and lunate was done using a geometric model in the reference position in order to create reference surfaces. The spatial location of each bone was obtained by the association of a reference surface to scatter plot [Mailhe, 2009] identified in the different positions of the wrist. The method is based on non-linear least square method and is providing a relative position between bones. This position is characterized by translation and rotation parameters of the scaphoid in the lunate reference frame. The residues of the best-fit method were linearly propagated to the parameters of the displacement.

Results

The orientation and position are provided with their uncertainties. The example of the flexion is presented in table 1. A 95% confidence interval is used.

Parameters	Mean	SD	95% confidence interval
α (°)	-9.152	0.347	-9.847 : -8.457
β (°)	-10.376	0.293	-10.963 : -9.789
γ (°)	-5.957	0.295	-6.547 : -5.367
T_x (mm)	-1.189	0.051	-1.291 : -1.087
T_y (mm)	-1.978	0.047	-2.073 : -1.883
T_z (mm)	0.823	0.081	0.660 : 0.986

Table 1: Orientation and position parameters of the scaphoid from the lunate in flexion position.

Discussion

The method proposed in this paper is based on the use of statistical information contained in the measurements data. Results show that the numerous points obtained from CT scan balance the lack of accuracy CT scan voxels.

References

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Neu *et al*, Journal of Biomechanical Engineering 122: 528-533, 2000.