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Definition eines lokalen Humerus-Koordinatensystem aus halbautomatisch segmentierten 3D Ultraschall-Bildvolumen des Schultergelenkes

Definition of a Local Humerus Coordinate System from Semiautomatically Segmented 3-D Ultrasound Volumes of the Shoulder Joint

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Introduction

For describing movements of all bones participating in a joint.s motion, it is important to be able to define a reproducible coordinate system for each of them. The International Shoulder Group (ISG) recommends the use of certain bony landmarks for the definition of local coordinate systems in the shoulder (fig.1). In a pilot study, we tried to determine whether such coordinate systems can be reliably defined for the humerus using only semiautomatically segmented, threedimensional ultrasound volumes acquired as freehand sweeps as a basis for finding the required landmarks.

Materials and Methods

Threedimensional volumes of the humerus of healthy volunteers were acquired using a conventional ultrasound imaging system. A localizer system (6DOF) was fixed to the system.s scanhead. An interactive application based on VTK and ITK was used for semiautomatic segmentation of all datasets. Owing to the varying quality of the representation of the depicted structures in each slice, which is partly due to the inclination of the scanhead towards a bone.s surface, a fully automatic segmentation has not yet been realized. Instead, a locally adaptive, semiautomatic segmentation process is

used to compensate for different demands depending on the anatomical region under consideration as well as the scanhead.s inclination. For segmentation, the humerus is divided into three parts: humeral head, shaft and region of the epicondyles. A rough starting region of interest is interactively defined for each part. Bony structures are then segmented automatically. In fig.2, threedimensional visualizations of the segmentation results for the humeral head are shown exemplarily.
The almost spherical surface of the humeral head is not completely visible in ultrasound volumes.
It is partly covered by other anatomical structures. To identify the parameters for an approximating sphere, a robust approximation algorithm is employed. The sphere.s center is then used as an estimation of the glenohumeral rotation center. The lateral and medial epicondyle are approximated using the most caudal points on the respective sides of the segmented bony surface of the humerus. When these three landmark regions conforming to the ISG requirements have been detected, the humerus coordinate system can be defined (fig.3).

Results

For all volumes, a reasonable segmentation was possible. Identification of the parameters for defining a local coordinate system for the humerus could be achieved by using the positions determined for the three required landmarks.

Discussion

Using our approach, segmentation and visualization of the humerus as well as the determination of a local coordinate system was successful. Expanding the study towards fully automatic processing of the humerus as well as the segmentation of the other bones forming the shoulder joint to determine a coordinate system for them as well remains to be done.

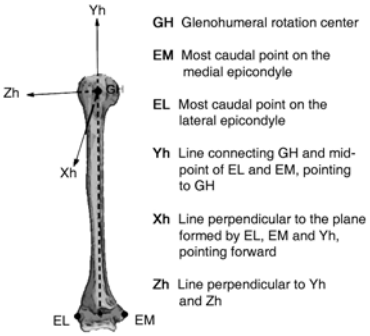

Fig. 1: Schematic drawing of the humerus, anterior view with coordinate system as defined in [1]

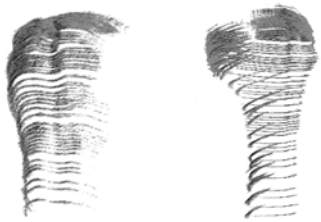

Fig. 2: Segmentation results: anterior (left) and posterior view (right) of the humeral head. In the anterior view, the intertubercular sulcus is clearly visible.

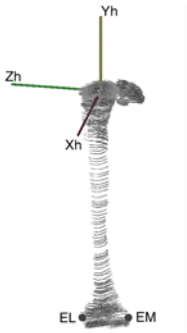

Fig. 3: Dataset from fig. 2 with local coordinate system (determined from the landmarks required by the ISG)