PROPOSAL OF A NEW WRIST MODEL FOR SURGICAL PLANNING: THE ADDED BENEFITS OF 3D ANALYSIS

Rémy Winter (1, 2), Thibault Poujade (2), Patrick Chabrand (3), Marc-Olivier Gauci (1)

1. Unité de Recherche Clinique Côte d'Azur, Université Côte d'Azur, France; 2. Newclip Technics, France; 3. Institut des Sciences du Mouvement Etienne-Jules Marey, CNRS, Aix-Marseille Université, France

Introduction

3D preoperative planning surgery is increasingly used with software already available for the shoulder, knee, and hip, but not yet for the wrist. Even though some manually constructed planning models for forearm surgery exist, they are time-consuming to build, making them unsuitable for clinical practice, and they have shown their limits in terms of measurements reproducibility [1,2]. The objective of this study is to propose a 3D measurement model at the distal radius considering geometric shapes (torus) that agrees within 5° with current models obtained with point landmarking.

Methods

Forty 3D forearm models (20 healthy and 20 pathological) were used in this study. For these 40 models, radial inclination in the frontal plane and volar tilt (or dorsal tilt) in the sagittal plane were measured using two different methods. On one hand, current methods consisting of landmarking anatomical points were used to obtain the two angles. On the other hand, angles were computed based on a new 3D developed model considering the main axis of the best-fitted torus on the radiocarpal surface (Figure 1). For both methods, the same longitudinal axis was automatically estimated analyzing cross sections of the radius shaft at various locations. The agreement between the two measurement methods was analyzed using Bland-Altmann method.

Results

Results of the Bland-Altman method are summarized in Table 1. The 3D developed model considering torus main axes underestimated radial inclination and volar tilt by respectively 2° and 1.5° on average when compared to the handmade point landmarking model. Ninety-five percent of the deviations between the two measurement methods were within [-5°; 1°] for radial inclination and [-6°; 3°] for volar tilt.

Discussion

This study shows an acceptable agreement between the measurements made by the developed 3D model and current handmade methods. The agreement is very good for the radial inclination (coefficient of repeatability of 3°) and good for the volar tilt measurement (coefficient of repeatability of 4.5°). The definition of volar tilt is more controversial in the literature as to which points should be considered. A comparison of five different volar tilt measurement methods showed a difference of more than 6° between two measurement methods [3]. The 3D developed overcomes this problem since the measurements are generated from the entire radiocarpal surface, thus homogenizing, and improving the definition of the distal radius measurements. In addition, it contributes to an improvement of the reproducibility and a considerable saving of time since the anatomical landmarks are currently manually positioned.

Figure and Tables

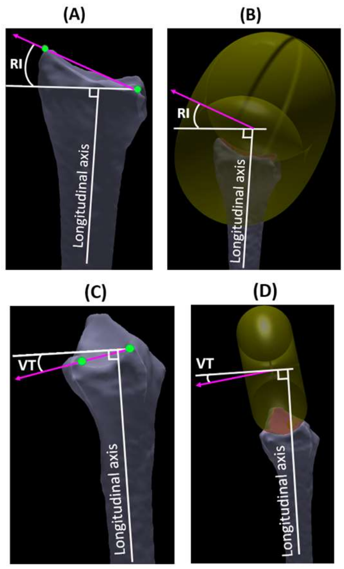

Figure 1: (A) Radial inclination (RI) measurement based on landmarking of radial styloid and medium ulnar border point; (B) RI measurement based on the main axis of the self-intersecting spindle torus; (C) Volar Tilt (VT) measurement based on landmarking of dorsal and palmar ulnar border points; (D) VT measurement based on the main axis of the torus.

Measurem-ent methods	Bias (°)	Limits of agreement (°)	
		Upper	Lower
RI (3D torus/points)	**-2** [-2.5; -1.5]	**1** [0.2; 1.8]	**-5** [-5.8; -4.2]
VT (3D torus/points)	**-1.5** [-2.2; -0.8]	**3** [1.8; 4.3]	**-6** [-7.3; -4.8]

Table 1: Results from Bland-Altman method

References

1. Winter et al, Hand Surg Rehabil, 41(6):741, 2022.
2. Daneshvar et al, J Hand Surg Am, 45(11):1082.e1-1082.e9, 2020
3. Daniele et al, J Hand Surg Am, 41(11):e399-e404, 2016.