

A NEW METHOD FOR EVALUATION OF THE CARRYING ANGLE IN-VIVO SET UP

M. L. Zampagni, S. Martelli, M. Motta and M. Marcacci
Biomechanics Laboratory, Rizzoli Orthopaedic Institute, Bologna, Italy

INTRODUCTION: The "carrying angle" is defined as the angle formed by the long axis of the humerus and the long axis of the ulna^[1,2]. This angle was measured in-vitro by several methods^[1] but few authors accomplished this measurements in vivo^[2] probably due to the difficulties related to the identification of repere points. The goal of this work was to define an easy, fast and accurate new method for evaluation of the carrying angle in an in-vivo set up usable in rehabilitation and sport fields. In this work we present the method, analyse its repeatability and we compare the results with measures performed using a goniometer.



Figure 1



Figure 2

METHODS: We examined 36 healthy and trained subjects. A passive electrogoniometer FARO ARM Figure 1 was used to digitize the 3-D coordinates of upper extremity landmarks according to ISB recommendations^[4]. The carrying angle was compute with a Good an Suntay method as the rotation around the axis perpendicular to the plane containing the ulnar and radial styloids and humeral epicondyles. The carrying angle was then measured using a goniometer similar to Paraskevas Figure 2 .

The repeatability of our method was tested performing carrying angle measure with the Faro Arm^[3] on 4 adult subjects (2 males and 2 females) by three different observers. The inter-subjects repeatability of our method was tested analysing the carrying angle measure on the complete group of subjects (70 upper extremities, 34 right and 36 left) by two observers. We finally compared the carrying values obtained with our method and goniometer.

Analysis Methods: The mean and SD were calculated for all measurements tab. After the normal distribution data were tested, ANOVA analyses were applied to establish statistical comparison.

RESULTS: We revealed a similar repeatability of our method among different operators and subjects. Repeated the carrying angle values differed a maximum by two degrees and the mean standard error was 0.5°.The comparison between carrying angle measurements obtained by FARO ARM and goniometer is reported in the Table 1.

Table 1 The Mean and SD of the carrying angle (CA) obtained by Faro Arm (FA) and Goniometer(GON).

| Subjects | cases | CA by FA mean and SD (deg) | CA by GON mean and SD (deg) |
|----------|-------|----------------------------|-----------------------------|
| males | 128 | 9.05 ± 0.44 | 10.81 ± 2.71 |
| females | 160 | 8.71 ± 0.49 | 11.60 ± 2.60 |

DISCUSSION: Our method showed the lesser error than goniometer and in vitro method reported in literature ($\pm 2^\circ$). The carrying angle values obtained by our method for 70 upper extremities were comparable with those found in previous studies. Our method presented an easy usability and the possibility to realize a detailed and precise description of the upper

extremity biomechanics using in both sportive and clinical issues. Further research is planned plan to analyze the variability of our protocol from equipment and anatomical landmarks.

REFERENCES:

- B. F. Morrey and E. Y. S. Chao : JBJS, (1976, 58a): 501-508.
Paraskevas G., et al. (2004). Surg Radiol Anat 26:19-23.
Martelli S. (2003). Comput Methods Programs Biomed. Mar;70(3):223-40.
Van der Helm FC et. al.(2004). ISB recommendation on definition of joints co-ordinate system of various joints for the reporting of human joint motion—part II: shoulder, elbow, hand and wrist. J Biomech.