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BIOMECHANICAL ROLE OF THE LACERTUS FIBROSUS OF THE BICEPS BRACHIALIS MUSCLE

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SUMMARY

The purpose of this paper is to present a protocol aiming to quantify the role of the lacertus fibrosus (LF) on the motion rhythm of the humero-ulnar and forearm joints. In-vitro motion measurements were collected by stereophotogrammetry. Motion data were collected in various conditions (intact LF, LF resected, variable loading weights). Motion data were then fused with the specimen 3D bone models obtained from medical imaging. Joint model building, including construction of anatomical frames, and motion representation occurred in a in-house software called "*lhpFusionBox*". Statistical comparison allowed then to quantify the motion differences between the untouched specimens and after LF resection. The data related to one specimen is reported in this paper as a feasibility study. Results for multiple specimens will be presented during the congress.

INTRODUCTION

Muscles like most structures of the human anatomy are mainly surrounded by conjunctive tissue which shapes fascias. Various types of fascias are described by various authors according to their composition, location or roles. For the last decade, fascias have been rediscovered and studied more thoroughly. However, the precise role of the fascias are still poorly described. This lack of quantified data opens up a large field for investigation about the mechanical role of fascias.

A particular kind of fascias is represented by fibrous expansions which connect some muscles to neighbour structures. For example, the Biceps Brachialis muscle (BBm) is mechanically linked to the superficial antebrachial fascia via a well-developed aponevrotic expansion. This expansion is called with different names in the literature: "*aponevrotic expansion of the muscle biceps*", "*bicipital expansion*" or "*lacertus fibrosus*" (LF). LF clearly reinforce and probably modify the mechanical action of the main BBm tendon ending on the radius (on the bicipital tuberosity). The LF is described as a "*fibrous blade emerging from the internal edge of the final tendon of the muscle biceps … it moves to the bottom and the inside, widens in range, and merges with the portion of the antebrachial aponevrose which recovers the muscle mass attaching on the medial epicondyle*." [1]. Recently, the LF has been divided into various layers attaching to various location [2]. This shows that the mechanical role of such structure, and the muscle attaching, is probably much complex then today functional description used for example for musculoskeletal modelling work. Althought not quantified, various roles are given to the LF fascia: -protect the brachial artery and the median nerve running underneath [2,3,4]; – the reinforcement of the ante-brachial fascia [4]; - the unloading of part of the BBm stress constraints generated by the main tendon on the radius [2,4-7]; - feedback role between the fascia and the muscle [7].The aim of our research was to investigate the LF biomechanical impact on the motion behaviour of the humero-ulnar and forearm joints.

METHODS

A fresh specimen, including a entire upper limb, was rigidly attached to an experimental jig. The BBm tendon, the Triceps Brachii m. tendon and the Brachialis m. tendon were attached through fishing wire to loading weights to simulate muscle tension. During loading, the specimen was analyzed by a motion capture system to measures amplitude of elbow flexion/extension, and forearm displacements (supination/pronation). Measurements are performed with different muscle loads: 1kg, 1.5 kg, 2 kg, 2.5 kg, 4 kg, 5.5kg, 7.5kg, before and after section of the LF fascia. These data were imported and fused with the specimen 3D bone models obtained from medical imaging using a in-house software (called “lhpFusionBox” presented in another paper at the ISB2011). Motion representation and statistical comparison allowed then to quantify the motion differences between the untouched specimens and after resection in order to deduce the relationships between the LF and the timing of the analyzed joints.

RESULTS AND DISCUSSION

Anatomical frame (AF) on the humerus was constructed according to the ISB convention, while novel AFs for the ulna and radius were built because of a lack of standard in the litterature (Fig. 1). Graphs (Fig. 2) representing the motion amplitude and timing for the humero-ulnar and foream joints (Flexion/Extension and Pronation/Supination, respectively) with and without LF were obtained.The LF seems to have a role of delaying the start of the radius supination and limits the amplitude of the same movement.

CONCLUSIONS

The protocol seems promising to analyse the LF role during the flexion of the elbow and the supination of the forearm. The same protocol is now running to collect data on supplementary specimens in order to confirm the results of this paper.

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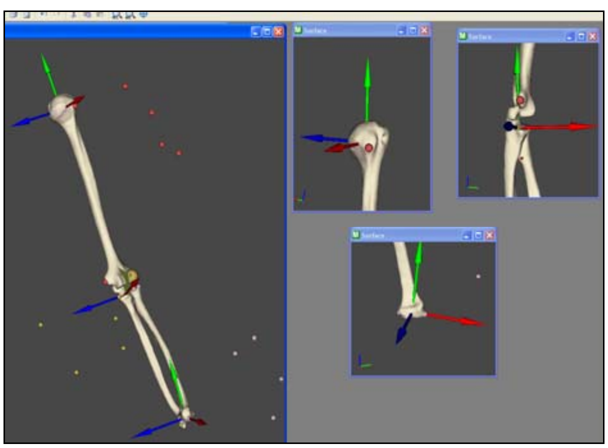

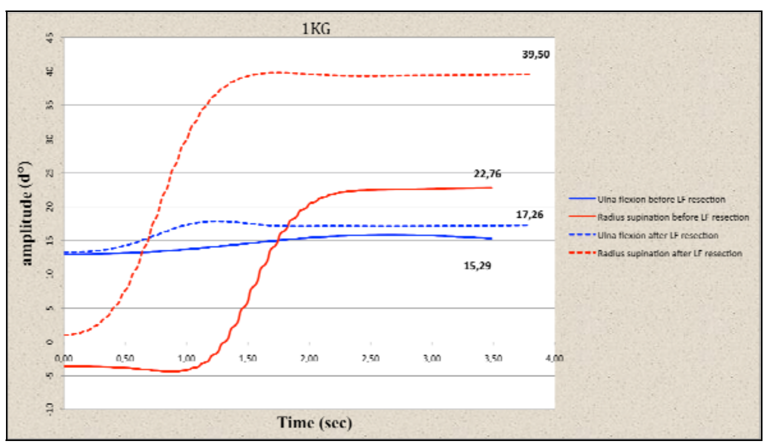

Figure1 (left): 3D bones models with the three reference systems. Figure 2 (right): motion graph (right side) with a 1 kg load. Note the limited displacement of the ulna (in blue) due to the small tendon loading. More data will be shown during the congress. For both figures: see text for details.