INTER INDIVIDUAL VARIATION IN TRUNK MUSCLES GEOMETRY OF ASYMPTOMATIC SUJETS IN STANDING POSITION.

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INTRODUCTION

Biomechanics models of the lumbar spine need specific muscular geometry data as maximal physiological area, centroid location of muscular areas in the intervertebral plane and muscular line of action or contraction. Those geometry data are usually acquired for supine subject. However, a significant difference exist when considering muscular centroid locations between the supine and the upright position [1]. The aim of this study was to characterize personalized muscular geometries of asymptomatic subjects in upright position and their related parameters in the L3/L4 intervertebral plane.

METHODS

19 asymptomatic subjects were recruited. Two exams were performed. First, a stereoradiographic exam consisting of two full spine X-Ray (frontal and lateral views) in standing position into a calibrated device was done [2]. With a specific software, the 3D personalized reconstruction of the vertebras (T1-L5), the pelvis and the ribs of the subject in upright position were obtained. Then, ten MRI axial slices were obtained from T9-T10 to L5-S1 levels and the femoral heads. The muscles outlined on the MRI were the Rectus Abdominis (RA), the External Oblique (EO), the Internal Oblique (IO), the Transversus Abdominis (TA), the Psoas (P), the Transverso Spinalis (TS), the Longissimus Dorsi (LoD), the Iliocostalis (IC) and the Latissimus Dorsi (LaD). The outlined muscles were then reconstructed and repositioned into the 3D spine reconstruction coordinates system using a specific technique based on muscles geometry adaptation regarding skin configuration in standing position and muscular bone attachment points [3]. A personalized volume reconstruction in standing position of each studied muscle was obtained between T9-T10 level and the femoral heads. Muscular volumes and intersection areas between the muscular reconstructions and the L3/L4 intervertebral plane were evaluated on left and right muscles. The centroid location of the muscular area was calculated with regard to the intervertebral disc centre. The orientation of the muscular line of action was quantified. The maximal physiologic area was evaluated as the maximal area of the intersected volume by a normal plane to the muscular line of action.

RESULTS AND DISCUSSION

The trunk muscles volumes and maximal physiologic area are shown in Figure 1. The largest muscles volumes were the Psoas (242 mL) and the RA (255 mL). The smallest volume was obtained for the QL (69 mL). The biggest variation between subjects was observed for the left Psoas (77%). The Psoas had the highest maximal physiologic area with 14 cm²,

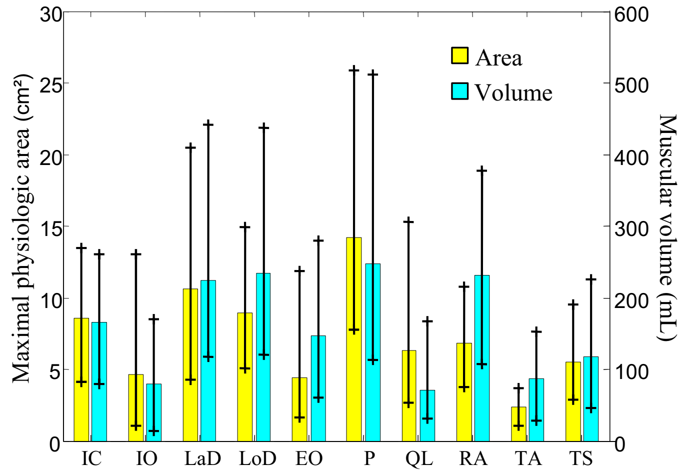

Figure 1 Maximal physiological areas and muscular volumes (mean, min, max).

followed by the LaD (11 cm²) as well as the IC and the LoD (9 cm²). A maximal physiologic area inter subject variability of 34% was observed for the LoD and the RA. The IO, LaD and RA had a high inter subjects variability for the postero-anterior centroid position (6.5-7.1 cm). The inter subject variability of the lateral centroid position for the IO, the LaD, the EO and the TA was between 4.6 and 6.8 cm. As for orientation of muscle line of action, variability between subjects could reached 46° for the LaD in the sagittal plane and 25° in the coronal plane. Furthermore, the TA had 70° of variation in the coronal plane. The muscles TS, Psoas and LoD had few variations between subjects for the area centroid position and the line of action orientation. Our data were in accordance with the few available data in the literature [4, 5].

CONCLUSIONS

The proposed muscular geometry in the L3/L4 plane took into account the muscular geometry shape and the muscular fiber orientation. A wide inter variability among subjects was observed, which underlined the need to personalized the muscular geometry for trunk muscular modelization.

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