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Modelling of iliopsoas tendon for psoas syndrome evaluation in THA

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Abstract

About 4 % of THA patients suffer from iliopsoas syndrome (IS). Modelling of the iliopsoas muscles is considered to be a reasonable aspect for identification of risk factors for IS. In this study we modelled the m. iliacus and the m. psoas major as separate muscles, consisting of 3 fascicles each. We analysed length and angular change of the fascicles from preoperative to postoperative state in a reference position on a database of 201 Japanese patients that underwent unilateral primary THA, with five of these patients being diagnosed with IS postoperatively. We did not find any correlation between length and angular changes and the appearance of IS. Further investigation is needed to find relevant risk factors for prediction of IS.

1 Introduction

About 4 % of THA patients suffer from pain caused by iliopsoas syndrome (IS) [1]. While enlarged anterior overhang of the cup is a known risk factor, literature shows up to 17 % of IS patients in whom the pathology is not caused by a critical overhang [2]. Furthermore, some patients develop IS without undergoing THA surgery [3]. As IS is a nonspecific term, multiple medical causes can be identified. In the context of THA mainly internal hip snapping (coxa saltans), iliopsoas tendonitis, labral injury and iliopsoas bursitis arise in this context [2,3,4,5]. Modeling of the iliopsoas muscles for integration in preoperative planning is therefore considered to be a reasonable aspect and has been investigated in this study.

2 Material & Methods

Basis for this study was an existing database of 201 Japanese patients that underwent unilateral primary THA, consisting of pre- and postoperative CT and EOS images. Segmentation and landmark detection were done following the process described by Fischer et al. [6]. Based on literature findings and visualized in Figure 1-A the m. iliacus (I, II and III) and the m. psoas major (IV, V and VI) were modelled as separate muscles, consisting of three fascicles each, with the medial part of the m. iliacus inserting at the lesser trochanter (1), together with the fascicles from m. psoas major and the intermediate and lateral part of the m. iliacus inserting about 25 mm distal and anterior from the lesser trochanter (2) [4,7,8,9]. The landmarks that define the origin of the psoas major were chosen as follows: (3) A point on the pelvic surface, 10 mm medial from the ASIS, (4) 20 mm distal from the most proximal point on the iliac crest, (5) 20 mm lateral from the IS joint, (6) transverse process of L4, (7) transverse process of L5, (8) intervertebral disk L4-L5. In the absence of segmented 3D meshes of the lumbar spine the landmarks that define the origin of the psoas major had to be defined by triangular mathematics, referenced to the sacral plateau.

In frontal plane the fascicles are modelled as straight-line connection between origin and insertion with intersection at the lig. inguinale for representation of the lacuna musculorum. In sagittal plane muscle wrapping was integrated around the protruding surfaces of femur and pelvis, or stem, cup and pelvis resp. for preoperative or postoperative analysis.

Length and angular changes of the tendon path between preoperative and postoperative state were evaluated. Following the literature, psoas syndrome related pathologies occur in the common tendon of the iliopsoas muscles, thus all fascicles inserting in the lesser trochanter (III, IV, V, VI) are considered for the analysis of cumulated length and angular changes from preoperative to postoperative state.

To ensure comparability a reference position was applied to the meshes. Therefore, the mechanical axis of the femur was aligned vertically and the pelvic tilt was adjusted. In addition, variation in the functional femoral anteversion was compensated for. Eight patients were excluded from analysis due to either missing or incorrect information about landmarks or mesh transformation, or morphological abnormalities that led to miscalculations of the tendon path, resulting in a cohort size of 193. Five of these patients were postoperatively diagnosed with psoas syndrome. For evaluation, whether length and angular change of the psoas tendon can be used as a predictor for IS, the length and angular change from these patients were compared to the results of the cohort.

3 Results

Length change

The mean length change aggregated over all patients and all four muscle fascicles mentioned above was 5.88 mm ± 7.81 mm with a maximum length change over all fascicles of 24.97 mm ± 1.28 mm. The mean length change for the individual fascicles was 7.13 ± 13.86 mm for the lateral iliacus tendon (I), 7.59 mm ± 13.54 mm for the intermediate iliacus tendon (II), 5.96 mm ± 8.35 mm for the medial iliacus tendon (III), 5.615 mm ± 8.03 mm for the psoas major tendon coming from L4 (IV), 7.19 mm ± 8.27 mm for the psoas major tendon coming from L5 (V) and 6.79 mm ± 8.29 mm for the psoas major tendon coming from the intervertebral disk L4-L5 (VI).

Angular change

Cumulated over all patients and the above mentioned four fascicles, the mean angular change was 0.70 ° ± 3.91 °, with a maximum value of 17.08 ° ± 2.62 °. The mean angular change for the individual fascicles was 0.65 ° ± 2.28 ° for the lateral iliacus tendon (I), 0.21 ° ± 4.47 ° for the intermediate iliacus tendon (II), 0.36 ° ± 1.92 ° for the medial iliacus tendon (III), 0.58 ° ± 3.82 ° for the psoas major tendon coming from L4 (IV), 0.83 ° ± 5.65 ° for the psoas major tendon coming from L5 (V) and 1.54 ° ± 4.77 ° for the psoas major tendon coming from intervertebral disk L4-L5 (VI).

IS diagnosed patients

The five patients diagnosed with IS showed a cumulated length change of 6.38 mm ± 6.92 mm. The length changes for the individual fascicles were found to be 2.49 mm ± 10.69 mm (I), 0.85 mm ± 11.66 mm (II), 5.59 ° ± 7.55 ° (III), 4.91 mm ± 8.42 mm (IV), 6.21 mm ± 6.43 mm (V) and 4.74 mm ± 6.75 mm (VI). The angular change for IS patients was 4.53 ° ± 2.23 ° and for the individual fascicles 4.00 ° ± 2.01 ° (I), 2.51 ° ± 1.51 ° (II), 4.32 ° ± 3.66 ° (III), 4.10 ° ± 2.97 ° (IV), 5.45 ° ± 2.72 ° (V) and 3.47 ° ± 3.00 ° (VI). Statistical analysis revealed no significant differences compared to the total of all patients for any of the investigated aspects.

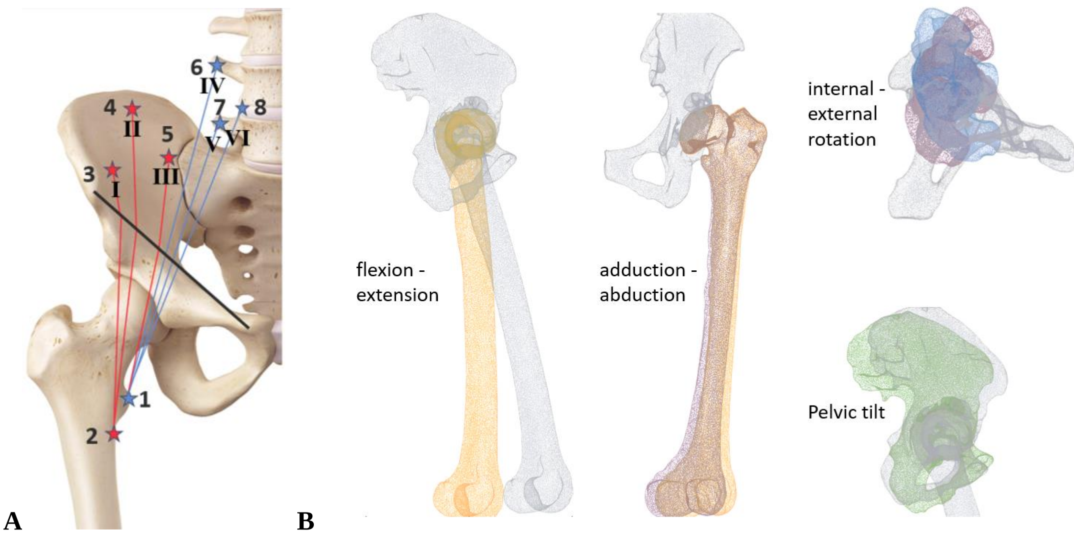

Figure 1: (A) model of iliopsoas muscles. 1: lesser trochanter, 2: insertion of m. iliacus, 3: origin of lateral iliacus fascicle, 4: origin of intermediate iliacus fascicle, 5: origin of medial iliacus fascicle, 6: origin of psoas major fascicle at L4, 7: origin of psoas major fascicle at L5, origin of psoas major fascicle at intervertebral disk L4-L5, (B): reference position applied to the meshes from EOS position

4 Discussion / Outlook

In our study we analysed the length and angular changes of the iliopsoas tendon within our model. Previous studies concluded, that alterations in the length of the psoas tendon could pose a risk for development of IS [2,3]. We could not identify any correlation between length and angular change from preoperative to postoperative situation and the appearance of postoperative IS. High length changes can increase the stress with that the tendon wraps over the bones. Protruding bony structures might therefore also be investigated with regard to the appearance of IS. However, it has to be noted that we only considered the theoretical length and angular changes, thus in a theoretical reference position. Especially high changes in length would be compensated for by posture variation of the patient. The variation of femoral anteversion and pelvic tilt might be an indicator for these posture changes and should be part of future investigations. It remains restrictive, that even these parameters might differ within patient´s posture during activities. More research on not only identification of the affected structures on patients with IS, but on risk factors for IS is desirable.

5 References

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