Original Article With Video Illustration

Contribution of the Ligamentum Teres to Hip Stability in the Presence of an Intact Capsule: A Cadaveric Study

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Purpose: To determine the contribution of the ligamentum teres (LT) to hip stability in the presence of an intact capsule with special attention to the change in range of motion and femoral head translation. **Methods:** Seven fresh-frozen cadaveric pelvises were used. Following visual inspection of the LT at different hip positions, internal rotation angles were measured at 10° of extension and at 0° of flexion, while external rotation was measured at 60°, 90°, and 110° of flexion with different hip abduction angles using electromagnetic motion tracking sensor. Femoral head translations were measured simultaneously. The tests were repeated after resection of the LT. The capsule was left intact for all test conditions. The results were compared between intact and LT resected conditions when torque of 2 and 4 Nm was applied. **Results:** Compared with the intact hip, the LT resected hip showed no significant difference when 2 Nm torque was applied in all scenarios. With 4 Nm torque application, significant increase in external rotation was found at 60° and at 90° of flexion (1.7° ± 0.8° and 2.1° ± 1.0°, respectively). Significant difference was also noted at 60°, 90°, and 110° of flexion when the hip was in the adducted position while at 90° in the abducted hip. However, LT resection did not show significant change in internal rotation. There was no significant difference in the translation distance of the femoral head in the intact hip compared with the LT resected hip (0.77-1.11 mm vs 0.79-1.29 mm). **Conclusions:** Our results indicate that within the physiologic range of motion, LT can minimally limit external rotation when the hip is in the flexed position but does not contribute to translation stability. **Clinical Relevance:** In the hip with intact capsule, LT deficiency can result in a slight increase in range of motion, but its contribution to stability is questionable.

The ligamentum teres (LT), also known as ligamentum capitis femoris, is commonly accepted as an embryonic remnant with no specific function in adults.[1,2] It is composed of 2 bands that have broad-based origin at the transverse ligament of the acetabulum and insert in the fovea capitis, posterior and inferior to the center of femoral head.[3,4] Despite detailed description of its anatomy and histology, the function of the LT remains controversial. The LT has been said to be an intrinsic stabilizer that resists joint subluxation,[5,6] a neurotransmitter of somatosensory signals that avoids painful and excessive range of motion,[7,8] a secondary structure that supplies femoral head blood supply,[2] and a synovial fluid distributor.[9] However, these proposed functions are mostly suggestive, and the rationales behind the hypotheses have not been thoroughly investigated.

The most debatable role of the LT is its contribution to hip stability. Recently, a number of clinical studies have reported favorable outcome after LT reconstruction in selected patients, implying its role as a potential hip stabilizer.[10-12] However, as the hip is surrounded by a thick capsule that is covered by ligamentous structures providing static stability to the hip joint, it is somewhat questionable whether the LT really provides any stability to the hip while the capsule is intact. Therefore, the best scenario for testing the contribution of the LT to hip stability is one where the capsule is left intact.

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Understanding the role of the LT in hip stabilization is important as it will help guide clinical, surgical, and rehabilitative techniques in patients with hip pathology.

The purpose of the current study was to determine the contribution of the LT to hip stability in the presence of an intact capsule with special interest in change in range of motion and femoral head translation. Our hypothesis is that within the physiologic range of motion, sectioning of the LT in cadaveric hips with intact capsules will not lead to any clinically significant changes in hip rotator or translatory stability.

Methods

Specimen Preparation

The cadaveric pelvises used for the current study were acquired from the Mayo Clinic's anatomic bequest program after approval from the institutional review board. Due to the potential joint contracture of the old age, only cadavers with age under 70 years were included in the current study. Before the pelvises were harvested from the original cadaver, all specimens were screened with fluoroscopy, and specimens with any evidence of osteoarthritis or structural deformities including acetabular dysplasia, coxa profunda, or cam- or pincer-type deformity were excluded. Two drill holes were made at the greater trochanter parallel to the epicondylar axis to mark the neutral version of the femur, and the pelvis was amputated between the second and third lumbar spine proximally and 25 cm distally from the greater trochanter. The pelvis was thawed at room temperature overnight, and all peri-capsular structures were dissected except for the tendinous insertion of abductor muscles at the greater trochanter. The hip joint was then inspected with a 70° arthroscope using a conventional anterolateral portal without the use of saline irrigation. To avoid disruption of the capsule, only slight manual traction was applied to the hip in order to insert the arthroscope. The quality of the LT was assessed by internally and externally rotating the hip joint. No further capsulotomy was made. With direct arthroscopic visualization, the presence and the quality of LT were evaluated by internally and externally rotating the hip joint with manual distraction. An additional portal was made at the acetabular notch under the transverse ligament to insert a probe if the quality of the LT was questionable. A specimen was excluded if it showed damage or poor quality of the LT, damage to labrum, or presence of intra-articular bony structure that could potentially limit the range of motion. Additionally, specimens with any sign of steroid injection on the capsule or within the joint, which was typically observed with the infiltration of white powder, were excluded. Out of an initial 13 cadaveric pelvises that were screened, 7 satisfied our inclusion/exclusion criteria, which included 4 males and 3 females with a mean age of 55.9 years (range, 48-69 years). The entire pelvis was used for the current study as both anterior superior iliac spine (ASIS) and posterior superior iliac spine were required to accurately define the orientation of the pelvis, but the test was performed on only one side of the hip to prevent the bias from testing on the structurally similar contralateral hip.

The pelvis was mounted on the conventionally made Plexiglass plate in the upright position with minimal use of metal materials to prevent any interference in the electromagnetic sensor (Fig 1). The custom-designed experimental apparatus allows the hip to move in flexion/extension, abduction/adduction, and axial rotation planes along the guide. As the testing cadaver was positioned in an upright position without musculotendinous attachments other than the capsule, slight distention of the hip joint occurred due to gravity. The sutures were attached to the abductor tendons in the greater trochanter, and the load was applied in 3 directions in order to represent the large attachment area of gluteus muscles, resulting in a total of 18 N along the course of the gluteus medius.[13-15] The

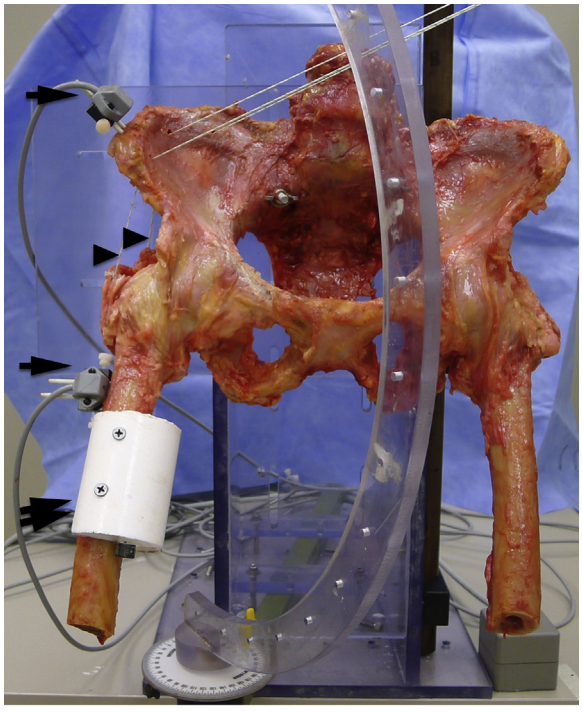

Fig 1. The setup of pelvis specimen in custom designed experimental apparatus. The specimen was secured on an acrylic glass plate and the torque was applied along the adaptor (double arrow) 6° varus to the anatomical axis of the femur. Electromagnetic sensors are attached at the iliac crest and on femur (arrows) and sutures were attached to abductors to maintain the femoral head within the acetabulum (arrow head).