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Methods to determine the volume of infrapatellar fat pad as an indicator of anterior cruciate ligament tear

Cheruvu, Bharadwaj, cheruvu.3@wright.edu; Goswami, Tarun, Wright State University, United States; Tsatalis, James; Laughlin, Richard, Miami Valley Hospital, United States

ABSTRACT

Introduction: Anterior knee pain is a common problem which affects adolescents and young adults. The most common mechanism for anterior knee pain arises from combination of compression and shear forces across the patellofemoral joint. The structures that commonly cause anterior knee pain include medial and lateral retinaculum, the patellar subchondral bone, the anterior synovium, joint capsule, patellar tendon, and infrapatellar fat pad. It is important to develop methods to measure volume of infrapatellar fat pad without invasive means. The volume of the fat pad was determined based on 3D image reconstruction using Mimics (a software developed by Materialise), by ellipsoidal methods a mathematical method, and program developed using MATLAB. All three methods had used MRI images to determine its volume. The objective of this study is to determine the accuracy of these new methods. The following hypotheses were tested: (1) increased volume of infrapatellar fat pad among torn ACL, (2) increased body mass index would have larger infrapatellar fat pad, and (3) volumes determined from Mimics, MATLAB, and ellipsoidal model would be accurate.

Methods: Our institutional review board approved this retrospective study, which involved a search of patient medical records, and waived the requirement for informed consent because there was no change in patient diagnosis or treatment. The study was an evaluation of all consecutive patients who complained of knee problems undergoing MRI examinations at our institution from 2007 to 2013. Two patient groups were evaluated after a search of surgery records for knee procedures: group 1 consisted of patients who had either a partial tear or complete tear of the ACL based on radiologists' reading on MRI. Group 2 consisted of patients with an intact ACL on MRI. MRI scans were performed using a 1.5 Tesla General Electric (Milwaukee, Wisconsin) signal MRI Scanner. T1 weighted images in 4-mm thick cuts were evaluated based on the integrity of the image. 3D reconstruction was performed using Mimics (Materialise) software.

Results: There is a strong correlation between the volumes determined by ellipsoidal model and MRI. It was determined that the coefficient of determination to be 0.9936. The volume estimated by MATLAB was found to be within a band of ± 2 MRI values (27.29 mm³; $R^2 = 0.4186$) and may be considered with high statistical confidence. No significant difference was observed between the two groups (*p* of 0.99 and 0.26) for ellipsoidal and MATLAB, respectively.

Conclusions: Volume determinations using ellipsoidal approximation model had been shown to be comparable to that determined by MRI and MATLAB code within a statistical band of ± 2 . No statistical significance was observed among methods, with *p* values of 0.99 and 0.26 for ellipsoidal and MATLAB, respectively. The volume and surface of fat pad in patients with torn ACL are significantly larger than those with intact ACL, *p* values of 0.01 and 0.04, respectively.