Measurement of the tibial anterior-posterior translation for Lachman test in the awake state and under anesthesia using electromagnetic measurement system.

Oka, S; Kuroda, R; Matsushita, T; Kubo, S; Nagamune, K; Araki, D; Matsumoto, T; Sasaki, H; Kurosaka, M; University of Kobe, Japan, University of Fukui, Japan, kurodar@med.kobe-u.ac.jp

Introduction: Anterior cruciate ligament (ACL) deficiency causes an increase in anterior tibial translation. To assess the amount of the anterior-posterior tibial translation, KT-arthrometer has been widely used. However it has been suggested by some reports that the practical reliability of the KT-1000 arthrometer measurement is doubted due to the inter- and intra-examiner errors. The Lachman test has been recognized as one of the most reliable clinical test for diagnosis of the anterior cruciate ligament deficiency. Precisely, we have developed an electromagnetic measurement system (EMS) to assess anterior knee laxity during Lachman test and reported that EMS provided more accurate measurement for determining the bony movement and had better correlation to the fluoroscopic measurement than KT-1000 arthrometer. However the study was conducted under anesthesia and it still remains to be tested whether the anterior knee laxity during the Lachman test can be measured accurately when the subjects were awake for daily practice. In this study, we assessed the anterior knee laxity using the EMS measurement system and compared the difference between under awake and anesthesia conditions.

Materials & Methods: Forty-seven patients who were injured unilateral complete ACL rupture diagnosed by physical examinations, magnetic resonance imaging and arthroscopy were assigned for this study (mean age: 26.5 years). Anterior tibial translations during the manual Lachman test were evaluated on the day before surgery when the patients were awake and the operative day when the patients were under general anesthesia before surgery using the EMS as previously reported. Briefly, the system consists of a transmitter that produces an electromagnetic field and three electromagnetic receivers. Two of the receivers which were attached to a plastic brace, were placed on the thigh at 10 cm above the patella and on the calf at 7 cm below the tibial tubercle respectively by a circumferential Velcro strap. Those receivers were used for motion measurement of the tibia and femur (Fig. 1). Seven anatomical landmarks were registered by digitizing with the third receiver which was attached to a specially made stylus to define the coordinate system. The 6 degrees of freedom of knee kinematics were calculated by modifying the principle of a 3-cylinder open-chain mechanism proposed by Grood & Suntay using the bone axis of the femur. The 6 degrees of freedom of the knee was recorded at the sampling rate of 240 Hz. Anterior/posterior position of the tibia was instantaneously monitored during the Lachman test. The examiner performed the Lachman test 5 times and the tibial anterior to posterior translations were recorded. The first and the last measurements among five times were omitted as outliers, because both of them were not continuous motion. The median data of the other three measurements was used for analysis. Lachman test was performed by applying anterior force on the tibia in a slightly externally-rotated position of the tibia. Tests were performed by a single experienced surgeon. The statistical difference was evaluated by paired t-test.

Results: The mean anterior translation of the tibia measured by the EMS during the Lachman test were 10.4 ± 0.50 mm in the intact knees and 15.4 ± 0.55 mm in the ACL deficient knees when the patients were awake, and 10.2 ± 0.54 mm in the intact knees and 17.2 ± 0.76 mm in the ACL deficient knees when the patients were under anesthesia (Fig. 2). The mean displacement of tibia in the ACL deficient knees was significantly larger than in the intact knees when the patients were awake and under anesthesia. In the ACL deficient knees, the mean displacement of the tibia was significantly larger when the patients were under anesthesia than awake. The mean side-to-side difference of the anterior tibial translation was 5.0 ± 0.50 mm when the patients were awake and 6.9 ± 0.65 mm when the patients were under anesthesia. The mean side-to-side difference of anterior tibial translation was significantly larger when the patients were under anesthesia than when the patients were awake (Fig. 3).

Discussions: The Lachman test has been shown to be the most accurate and reliable clinical test for diagnosis of the ACL rupture, with 20 degrees of flexion manifesting the greatest difference in anterior/posterior translation of the tibia between injured and intact knees. Our noninvasive EMS made the Lachman test a quantitative examination and further provided data on the exact number of anterior/posterior tibial displacements during the Lachman test. In the present study, however, the mean side-to-side difference of the anterior tibial translation measured by the EMS during Lachman test was significantly larger when the patients were under anesthesia than awake. These observations suggested that Lachman test tends to be affected by the patients’ consciousness and muscle relaxation in the ACL deficient knees. When quantifying the amount of anterior tibial translation during Lachman test, it needs caution if the test is performed when the subjects are awake.

References: