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Comparative postural stability in patients with lateral meniscus versus medial meniscus tears

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ABSTRACT

Background: Types of mechanoreceptors may differ between the medial and lateral menisci, suggesting that postural stability may differ between patients with medial and lateral meniscus tears. However, to date, postural stability has not been compared in patients with medial and lateral meniscus tears. This study used stabilometry to compare postural stability in patients with medial and lateral meniscus tears.
Methods: Postural stability and thigh muscle strength were assessed in 24 patients with medial and 18 patients with lateral meniscus tears. Postural stability was determined by measuring the anteroposterior (APSI), mediolateral (MLSI), and overall (OSI) stability indices using stabilometry. Maximal torque (60°/s) of the quadriceps and hamstring was evaluated using an isokinetic testing device.
Results: The three stability indices, OSI, APSI, and MLSI, in both involved and uninvolved knees were all significantly greater in patients with lateral than with medial meniscus tears. ($P < 0.001$ for all OSI, APSI, and MLSI in both involved and uninvolved knees, except for $P = 0.005$ for MLSI of involved knees). In patients with medial meniscus tears, both OSI (1.4 ± 0.4 vs. 1.1 ± 0.4, $P = 0.037$) and MLSI (0.9 ± 0.3 vs. 0.8 ± 0.3, $P = 0.041$) were significantly higher on the injured than the uninjured side. In patients with lateral meniscus tears, none of the stability indices differed significantly between injured and uninjured knee joints.
Conclusion: Postural stability of both the injured and uninjured knee joints was poorer in patients with lateral than with medial meniscus tears.

1. Introduction

The anterior and posterior horns of the meniscus contain numerous mechanoreceptors, including Ruffini endings (slow-adapting mechanoreceptors) and Pacinian corpuscles (rapidly adapting mechanoreceptors), which provide information on the position and motion of the joint [1,2]. Because sensory information associated with a patient's conscious perception of joint motion via mechanoreceptors in the meniscus may contribute to postural stability [3–6], a reduction in proprioception due to mechanoreceptor damage resulting from meniscus tears may be associated with a reduction in postural stability.

Altered postural stability has been reported in patients with tears, repair, and/or meniscectomy of the medial meniscus (MM) alone [7–9]. The incidence of lateral meniscus (LM) tears is comparable to that of MM tears, with several previous studies suggesting that postural stability may differ between patients with MM and LM tears, due to differences in mechanoreceptor distribution between

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the MM and LM [10–13]. However, to date, postural stability has not been directly compared in patients with MM and LM tears. Therefore, the current study compared postural stability in patients with MM and LM tears. It was hypothesized that postural stability would be similar in these groups of patients.

2. Materials and methods

2.1. Patient enrollment

This prospective longitudinal trial enrolled all patients scheduled to undergo meniscus repair or meniscectomy for isolated MM or LM tears, as confirmed by magnetic resonance imaging (MRI) and physical examination. Patients with concomitant ligament tears were excluded, to eliminate bias resulting from torn ligaments. Also excluded were patients with MM and LM tears in the same knee joint, those with meniscus tears in both knees, prominent signs of knee osteoarthritis (Kellgren–Lawrence grade III or IV) on plain radiographs, a history of previous knee injury and receipt of any rehabilitation protocol, or discoid LM tears. Patients were also excluded if they were unable to perform the isokinetic muscle strength or postural stability tests due to pain or limited motion of the knee joint resulting from effusion, vestibular or neurological dysfunction, or visual impairment.

2.2. Postural stability test for proprioception

Postural stability and isokinetic thigh muscle strength in all patients were assessed by a single rater blinded to the side of injury. Postural stability tests were performed on both injured and uninjured knees using the Biodex Stability System (BSS) (Biodex Medical Systems, Shirley, NY), with a movable balance platform that provided up to 20° of surface tilt in a 360° range of motion. This platform, which interfaced with computer software (Biodex, Version 1.32), enabled the device to objectively assess balance. Participants were instructed to: stand with one bare foot on the BSS locked platform; keep the other foot off the ground in a comfortable position; keep their arms at their sides; and look straight ahead at a point on the wall approximately one meter away at eye level. As soon as the subject was able to maintain this point, indicating that his/her location was on the center of pressure, the examiner recorded the foot location using a coordinate system consisting of the lateral malleolus and the heel cord on the foot plate. After positioning, subjects were instructed to maintain the same position of their feet until the end of each test. Subjects unable to maintain balance during testing were allowed to briefly touch their toes with the opposite foot or grasp the handrails for a short time to re-establish balance as soon as possible. If a subject was unable to quickly re-establish balance, that test was canceled. Each test consisted of two trials, starting at level 12 (most stable) and gradually decreasing to level one (least stable), with the stability level automatically declining every 1.66 s. Two test evaluations of 20 s each were performed, with 10 s between each pair of tests.

The mean and standard deviation of the two trials were calculated by the stability system. The measures of balance and postural stability included anteroposterior (APSI), mediolateral (MLSI), and overall stability index (OSI) scores. A lower stability index was associated with a more stable platform, indicating greater dynamic balance or postural stability of the subject.

2.3. Assessment of isokinetic strength

Isokinetic knee extension/flexion (concentric/concentric muscle contraction) strength was measured with each subject seated on a Biodex multi-joint system 4 (Biodex Medical Systems) with his/her trunk perpendicular to the floor, and hips and knees flexed to 90°. A strap was used to immobilize each subject's thigh, and the dynamometer attachment was aligned to the lateral malleolus of the lower leg of the knee being tested. Before each test session, each individual performed a set of five warm-up submaximal knee flexions and extensions of each leg at 60°/s. Each test session consisted of five isokinetic knee extensions and flexions (range of motion, 80–0°) of each leg at 60°/s, with a rest time of 30 s between tests. Peak flexion and extension torques were recorded (N·m/kg). Extensor strength was regarded as quadriceps strength, and flexor strength was regarded as hamstring muscle strength. The mean value of two trials was regarded as the maximal peak torque of the hamstring and quadriceps.

2.4. Statistical analysis

Based on a previous study for postural stability in patients with knee joint injuries [14], an OSI difference >0.5 between groups with MM and LM tears was regarded as clinically important. A priori power analysis was performed to determine sample size, using a two-sided hypothesis test at an alpha level of 0.05 and a power of 0.8. The results of a pilot study involving five knees in each group indicated that 15 knees would be required to detect a significant between-group difference in OSI >0.5, which was the primary outcome measure. The overall power of this study for detecting a significant between-group difference in OSI was 0.932.

To quantify the test–retest reliability of isokinetic strength and postural stability, intraclass correlation coefficients (ICCs) were calculated for two trials of maximal peak torques of the quadriceps and hamstring. ICCs were also calculated for two measurements of each stability index. ICC values >0.75, between 0.4–0.75, and <0.4 were regarded as representing good, fair, and poor reliability/accuracy, respectively.

The mean values of stability indices, the strength of the hamstring and quadriceps muscles, and their ratio were compared between the MM and LM tear groups, and on the uninvolved and involved sides, using Student's *t*-tests. A *P*-value <0.05 was regarded as statistically significant. Data were analyzed using SPSS software version 12 (SPSS Inc., Chicago, IL, USA).

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