Ultrasonographic Findings in Hemiplegic Knees of Stroke Patients

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Clinical and radiologic asymmetric arthritic differences between paralyzed and nonparalyzed limbs of stroke patients have been reported. Arthritic pathology aggravates motor dysfunction and compromises rehabilitation. Musculoskeletal ultrasonography plays an important role in showing soft tissue and the articular cartilage of the knee. Fifty-nine patients with either ischemic or hemorrhagic stroke-induced right or left hemiplegia were recruited to evaluate soft-tissue and intra-articular cartilage changes in hemiplegic knees of stroke patients using ultrasonography. An additional 15 subjects (30 knees) without knee disease or a history of knee trauma or surgery were used as controls. There were significant differences in suprapatellar effusion and patellar tendinitis between hemiplegic and nonhemiplegic knees. Suprapatellar effusion and pes anserinus tendinitis were correlated with Brunnstrom stage. The length of time since stroke onset was not significantly correlated with positive ultrasonographic findings in hemiplegic knees. In conclusion, ultrasonography is useful for detecting periarticular soft-tissue changes and intra-articular lesions in hemiplegic knees of stroke patients.

Key Words: ultrasonography, hemiplegia, knee, stroke
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Cerebrovascular accidents frequently cause upper motor neuron syndrome, including weakness, spasticity, and abnormal gait pattern or synergistic movement. The impairment of lower limb function results in an asymmetric and interrupted hemiplegic gait because patients prefer to bear weight on the unaffected limb. Biomechanical changes in both limbs lead to soft-tissue injuries and arthritic cartilage changes may be suspected [1,2].

Segal et al reported that paralyzed hands show significantly fewer osteoarthritic changes than nonparalyzed hands, both clinically and radiologically, and that the severity of paralysis and loss of muscle strength correlate with the degree of osteoarthritis (OA) asymmetry [3]. In rheumatoid arthritis, where symmetry is a diagnostic criterion, it has been reported that impairment of the nervous system alters arthritis symmetry [4]. In arthritis of the lower limbs, involvement of the knee is the most common cause of disability in older people or hemiplegic patients. In patients with hemiplegia, knee arthritis induces joint pain, limited range of motion (ROM), loss of muscular strength, and eventual motor dysfunction. Therefore, early detection of arthritis in stroke patients is important, and ultrasonography plays an important role in screening and follow-up [5].

Roentgenography and magnetic resonance imaging (MRI) are commonly used to evaluate arthritic knees. While radiographs of the knee are usually obtained first, these provide little information on soft-tissue structures. Though an MRI can provide more information about soft-tissue changes in knees, including cartilage, tendons, ligaments, menisci, and bone marrow, it is expensive and there is a lack of dynamic real-time assessment [6].

Ultrasonography is increasingly advocated as a valuable diagnostic tool for evaluating the knee joint. It has many

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advantages, including its noninvasive nature, low cost, portability, dynamic real-time assessment, and easy side-to-side comparison. It provides quality images of the knee joints, including the synovial sac, tendons, ligaments, meniscus, and articular cartilage. In addition, the use of extended field imaging has helped in the imaging of larger anatomic structures; and split-screen imaging is beneficial in comparing the changes in both knees [5,7,8].

Currently, no paper has discussed soft-tissue and cartilage changes in stroke patients. This study was designed to use ultrasound to investigate structural changes in bilateral knees of hemiplegic patients, to analyze the correlation between sonographic findings and both post-stroke duration and motor status, respectively. The probable risk factors for knee joint lesions were also assessed.

Methods

Subjects

Fifty-nine ischemic or hemorrhagic stroke patients with right or left hemiplegia were recruited between January and April 2004. The bilateral knees were evaluated using high-resolution ultrasound. Patients were excluded if they had knee injury in the past 6 months, a history of knee OA or other form of arthritis, or a history of knee surgery. An additional 15 subjects (30 knees) without knee disease or a history of knee surgery were used as controls. In terms of age and sex ratio, the control group was not significantly different from the experimental group, as determined by independent-samples *t* test and Fisher's exact test.

Sex, age, height, weight, body mass index (BMI), diabetes mellitus status, hypertension, motor status (Brunnstrom stage), and the interval from the onset of hemiplegia were recorded. The severity of knee pain was measured using a visual-analog pain scale, and signs of local inflammation and ROM of the knee joint were also assessed.

Ultrasound assessment

Ultrasonography was performed on bilateral knees using a real-time 5–12 MHz high-resolution linear scanner (HDI 1500, Advanced Technology Laboratories, Bothell, WA, USA). The techniques used in this study have previously been described [5,7–11].

To examine the suprapatellar pouch and patellar tendon, the patient was placed in a supine position with knee flexion of 30°. The transducer was swept along the suprapatellar pouch, from medial to lateral or lateral to medial, to give a longitudinal image. The transducer was then swept from the patella to the tibial tuberosity, to give both longitudinal and transverse images. The pes anserinus tendon insertion, 2.5–3 cm distal to the medial joint line, was located with the transducer placed longitudinally.

The deep infrapatellar bursa was examined with the transducer positioned longitudinally between the patellar tendon and tibia. The femoral condylar cartilage and knee joint space were viewed with subjects supine and with knees held at maximum flexion (about 120°); the superior margin of the medial and lateral femoral condyle and the center of the intercondylar groove were used as markers.

Ultrasonographic diagnostic criteria

Suprapatellar effusion was defined as transducer-compressible localized anechoic or hypoechoic fluid in the suprapatellar pouch (Figure 1).

Ultrasonographic images of acute patellar tendinitis show the tendon to be thickened and hypoechoic. In chronic tendinitis, the tendon is thickened, heterogeneous, and hypoechoic. The maximal thickness of the normal patellar tendon is about 4–5 mm and the width is about 20–25 mm; thickening is defined as patellar tendon thickness greater than 5 mm (Figure 2) [12].

Pes anserinus tendinitis was characterized by thickening and loss of the normal fibrillar echotexture. Bursitis was defined as a circumscribed anechoic fluid collection of 2 mm or more (Figure 3) [13,14].

Baker's cyst was defined as a hypoechoic mass in the popliteal space, measuring at least 1 cm in two dimensions. The characteristics are visualization of the stem of the cyst, originating in the medial aspect of the popliteal fossa, between the semimembranous tendon and the medial gastrocnemius head.

The characteristic sonographic features of osteoarthritic cartilage are loss of the normal sharpness of the synovial space cartilage interface, loss of clarity of the cartilaginous layer, narrowing of the joint cartilage (thickness < 2 mm), and increased intensity of the posterior bone–cartilage interface (Figure 4).

Statistical analysis

Chi-squared analysis was used to determine the differences in ultrasonographic abnormalities between the hemiplegic and nonhemiplegic knees, in the durations from the onset of hemiplegia, and in the motor status of the hemiplegia. We defined p less than 0.05 as a significant difference. The independent samples *t* test was used to determine the difference in mean age between stroke patients and control subjects. Fisher's exact test was used to determine the