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Case Series

Diagnosis and treatment of subchondral bone insufficiency fracture of the knee joint: case series

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ABSTRACT

Subchondral insufficiency fracture of the knee (SIFK) is a stress fracture that happens under the cartilage usually due to repetitive stress to the bone which is already weakened by non-cancerous diseases which impacts the bone strength and fragility. SIFK is a new nosologic entity that has replaced the diagnosis of spontaneous osteonecrosis of the knee. Primary avascular necrosis of the femoral condyles is a differential diagnosis of subchondral fracture of bone insufficiency of the knee joint, which requires a different approach to treatment. The aim of our study was to evaluate the effectiveness of conservative treatment of subchondral bone insufficiency fracture of the knee joint (SIFK).

Keywords: SIFK, Spontaneous osteonecrosis of the knee joint, Stress fracture, Osteoporosis, Osteopenia, Osteoarthritis

INTRODUCTION

The diagnosis of spontaneous osteonecrosis of the knee joint was first described by Ahlbäck in 1968, the cause of which was long considered to be bone tissue ischemia leading to necrosis.[1] However, subsequently there appeared data on the absence of the role of ischemia in the pathogenesis of spontaneous osteonecrosis of the knee joint.[2-4] Pathomorphologic study revealed the presence of fractured subchondral bone trabeculae with signs of bone regeneration and the absence of foci of bone tissue necrosis.[2,5-8] Currently, most authors recommend replacing the term "spontaneous osteonecrosis of the knee joint" and "post-arthroscopic osteonecrosis" with "subchondral bone insufficiency fracture of the knee joint" because the former does not reflect the pathogenesis of the disease.[4,9-11]

The main cause of subchondral bone insufficiency fracture of the knee joint of this pathology is a decrease in bone density or overloading of the subchondral bone due to damage to hyaline articular cartilage (chondromalacia, meniscus damage or resection, anterior cruciate ligament grafting).[4,14,15] However, there is evidence that decreased bone density does not always cause SIFK.[16]

The commonest site of lesion is the central part of the medial condyle of the femur, less frequently the plateau of the tibia.[10,15] In 89% of the patients the inner compartment of the condylar joint of the femur and tibia is the prime location for the lesion.[15]

Patients with SIFK complain of acute knee pain, often worse at night and poorly controlled with NSAIDs. Joint effusion, crunching and Baker's cysts are often observed.[10]

When performing radiography at the early stage of the disease, the radiographic picture corresponds to normal, only later there appear characteristic signs of complications of Subchondral bone insufficiency fracture

of the knee joint-subchondral collapse and deformation of the articulating surfaces.[9,10,17]

Magnetic resonance imaging allows detecting signs of the fracture at an early stage of the disease when radiographic examination is still normal.[13,18]

Currently, there is no recognized treatment algorithm for patients with SIFK.[20] The main methods of treatment are prevention of subchondral collapse, creation of conditions for bone consolidation, and elimination of risk factors such as chondromalacia and meniscus damage.

CASE SERIES

This is a case series study carried out between September 2022 to December 2023 at the Grodno emergency hospital and Grodno outpatient clinic 'lode', 25 female patients diagnosed with SIFK were examined and treated. The mean age was 62±14 (48-76 years). The mean follow-up period was 8±6 months. The time frame from the beginning of symptoms in the form of knee pain up to the diagnosis averaged 10 weeks. All patients had a lesion in the medial condyle of the femur.

Inclusion criteria in the study were the signs of clinical picture in the form of appearance of sudden pain, absence of traumatic history, presence of signs of Subchondral bone insufficiency fracture of the knee joint according to MRI: swelling of bone marrow in hyperintense signal in T2 weighted scan, hypointense fracture line in T2 and PD scanning modes.

Exclusion criteria were as follows: presence of trauma or surgical intervention of the knee joint in the last 3 months, knee joint pain lasting more than 1 year, existence of risk factors and signs of primary avascular necrosis: alcoholism, gluco-corticosteroid use, rheumatoid diseases, chronic kidney disease, "double line" sign and serpiginous borders of the lesion focus.

MRI study was performed on a Philips Ingenia 1.5 Tesla tomograph (Philips, Germany). All patients underwent knee radiography in 2 projections before MRI, and the level of vitamin D concentration in blood, total and ionized calcium, dual-energy X-ray absorptiometry (DXA) on STRATOS dR osteodensitometer (DMS, France) was measured.

MRI scans assessed lesion size in the frontal and sagittal planes. In ellipse-shaped lesions, the bone volume under the fracture line was estimated using the formula $4/3\times(\pi abc)$, where a is the anteroposterior dimension of the lesion while b is the transverse dimension and c is the cranial-caudal dimension of the lesion (Figure 1).

The treatment was programmed with a 3-month orthopedic regimen, including reduction of axial load on the limb and use of crutches for 2 months, followed by transition to a cane for another month. High-intensity pulsed magnetic field magnetotherapy was used in all patients.[21] If vitamin D and calcium concentrations were below the reference values, supplemental therapy with vitamin D and calcium preparations was used. To control pain syndrome all patients were prescribed NSAIDs from the group of oxicams and coxibs.

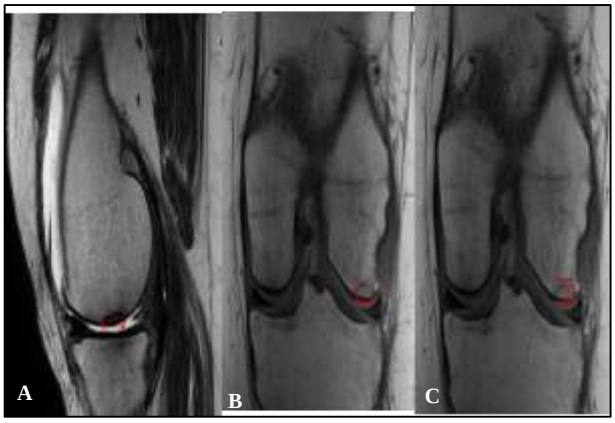

Figure 1 (A-C): Evaluation of anteroposterior, transverse and cranial-caudal dimensions of the subchondral insufficiency fracture.

The effectiveness of the therapy was evaluated 3 and 6 months after the beginning of treatment. The severity of pain syndrome was assessed by visual analog scale (VAS).

Mean vit D concentration was 25±7 ng/mL. Total and ionized calcium concentrations were within the normal range of 2.54±0.3 and 2±0.6 mmol/L, respectively.

Densitometry scores averaged T score -1.5±0.9, Z-score -1.9±0.4, which indicated the presence of osteopenia and osteoporosis. Osteoporosis being a common disease among post-menopausal women due to the absence of estrogen in the body explains the strong correlation of the occurrence of SIFK among postmenopausal women.[15]

Before the start of treatment, the severity of pain syndrome was 7.2 and 1.2 six months after the start of treatment.

A complication in the form of subchondral collapse occurred in 6 of 25 patients with Subchondral bone insufficiency fracture of the knee joint (Figure 2).

Figure 2: Subchondral collapse in patient O. Two months after initiation of therapy and 8 months after onset of symptoms.

This type of complication is associated with late diagnosis of the disease (later than 6 months from initiation of symptoms) and lesion that was considered large. The chances of missing a subchondral fracture may be because in some cases it does not show in a radiograph in the initial visits.

Conservative treatment led to disease regression in 6 out of 8 patients (Figure 3).

High-intensity pulse magnetotherapy on BTL-6000 super inductive system elite apparatus was used for physiotherapeutic treatment.

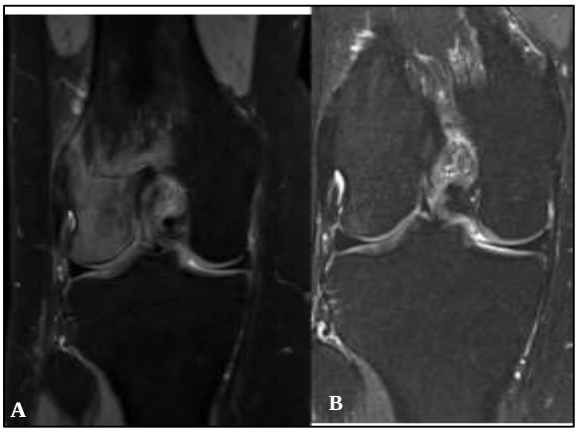

Figure 3 (A and B): Knee joint MRI of patient K, at the beginning of treatment and after 3 months.

DISCUSSION

Low levels of vitamin D and results of densitometry confirmed results that main causative factor of subchondral bone insufficiency fracture of the knee joint developed due to low bone density.[15,17]

Risk factors for unfavorable prognosis in SIFK have also been identified: marked bone marrow edema, chondromalacia of the 3rd and 4th degrees, concomitant meniscus damage, the focal area surrounded by the fracture line measures more than 16.5 mm in the sagittal plane and 10.5 mm in the frontal plane (in total, more than 26 mm).[10] Pareek identified factors that lead to the progression of osteoarthritis and increase the risk of knee joint endoprosthesis: age over 65 years, location of the focal fracture in the medial condyle of the femur and tibia, genu varum, and extrusion of the internal meniscus.[15] The volume of articular movement in the initial period of the disease is an important prognostic sign.[12]

In our study patients with size of lesion more than 14.1 mm in anteroposterior, 10.2 mm in transverse and 1.2 mm in cranio-caudal direction had complication like subchondral collapse of articular surface that developed during 6 months after the diagnosis.

Success of magnetotherapy in our study confirm investigation of Muccioli et al.[21]

In case of a large lesion area, high corrective osteotomy of tibia (in young patients in the absence of subchondral collapse), radiofrequency ablation of the geniculate nerves can be used to improve the biomechanics of the knee joint, and if subchondral collapse develops, uni-condylar or total knee arthroplasty can be used.[10,11,17, 19]

CONCLUSION

In this case series, we successfully investigated the outcomes of conservative management of patients with SIFK focusing on patients with low bone mineral density (BMD) and specific lesion dimensions. We were able to conclude that conservative management proved to be an effective treatment strategy when associated with MRI diagnostic techniques, which proved to be the gold standard investigation providing comprehensive insight into the extent of the lesion; it's size and location along with associated complications.

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