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Development of osteonecrosis after arthroscopic meniscal and chondral knee surgery: a report of five cases

Artroskopik menisküs ve kıkırdak cerrahisinden sonra osteonekroz gelişimi: Beş olgu sunumu

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Artroskopik cerrahiden sonra gelişen osteonekroz, menisektomi, kıkırdak cerrahisi ve termal enerji kullanımıyla ilişkilendirilmiştir. Bu yazıda beş olgudan oluşan bir hasta grubu sunuldu; bunların dördünde zaman aralığı olarak artroskopi sonrası nekroz ölçütleri (artroskopi öncesi manyetik rezonans görüntüler yakınmaların başlamasından en az dört hafta sonra elde edilmişti) vardı. Dört olgu konservatif olarak takip edilirken, birine artroskopik debridman ve mikrokırık girişimi uygulandı. Travma olmaksızın yakınmalarda ani artış ortaya çıkan dejeneratif artritli dizlerde ve artroskopik menisküs veya kıkırdak cerrahisinden sonra yakınmalarında artış görülen olgularda osteonekroz tanısı akla gelmelidir. En uygun tedavinin ne olduğu konusundaki tartışmalar devam etmektedir.

Anahtar sözcükler: Artroskopi/yan etki; diz eklemi/cerrahi; menisküs, tibial/cerrahi; osteonekroz/etyoloji.

The development of osteonecrosis after arthroscopic surgery has been associated with meniscectomy, chondral surgery, and the use of thermal energy. This paper presents five cases, four of which fulfilled the temporal criteria for postarthroscopy necrosis, i.e. presurgical magnetic resonance imaging was obtained at least four weeks after the onset of symptoms). Four cases were treated conservatively while one underwent arthroscopic debridement and microfracturing. The diagnosis of osteonecrosis should be kept in mind in osteoarthritic patients whose knee symptoms manifest a sudden increase without trauma, and in cases with worsening knee symptoms after arthroscopic surgery. The optimal treatment strategy in these patients is still debatable.

Key words: Arthroscopy/adverse effects; knee joint/surgery; menisci, tibial/surgery; osteonecrosis/etiology.

Development of osteonecrosis after arthroscopic meniscal and chondral knee surgery is a rare but serious complication. It was evaluated in approximately 20 different studies after its first description by Brahme et al. in 1991.[1-10] The patients with osteonecrosis are over 50 years of age and with a history of an arthroscopic procedure for degenerative meniscal tear and/or chondral lesion. Osteonecrosis is most often localized in the same compartment of which the surgery performed and become increasingly symptomatic 2 to 6 months after the first surgery. Osteonecrosis can develop after usage of either mechanical devices or laser probes. In the literature, the photoacustic and thermal effects of the laser probe, leading to cell death, was proven as the causative effect of the osteonecrosis.[11-14] In some clinical trials, the risk of necrosis was shown to be decreased by lowering the energy level of the probe and tangential application.[15] Apart from different mechanisms, osteonecrosis after arthroscopic surgery can result in different additional surgical procedures like as osteotomies or arthro-

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plasties and can decrease the patients' satisfaction.

In this study, the absence of osteonecrosis after arthroscopic surgery was proven by magnetic resonance imaging (MRI) and four cases which developed osteonecrosis in the follow-up were reported with a discussion of the literature. In none these four cases, there were no risk factors, that can be associated with secondary osteonecrosis like as cortizol usage, systemic lupus erythamatosis etc. For the impaction of the topic, a patient with ignored early signs of osteonecrosis on preoperative MRI and who had collapse after arthroscopic menisectomy was also included as the fifth case.

Case 1– A 60 year-old male patient was admitted to our clinic with a complaint of increasing knee pain and effusion in the last one month. The patient had a history of left arthroscopic menisectomy , lavage and thermal energy chondroplasty 6 months ago for the diagnosis of degenerative meniscal tear. He had had a short period of pain relief postoperatively lasting for one month and then his complaints, pain and swelling, had started again leading him to a waddling gait. In the physical examination, patient's left knee had a moderate effusion and pain by palpation on the left medial femoral condyle. Medial McMurray test was positive with a click sound and pain. His preoperative MRI which had been per-

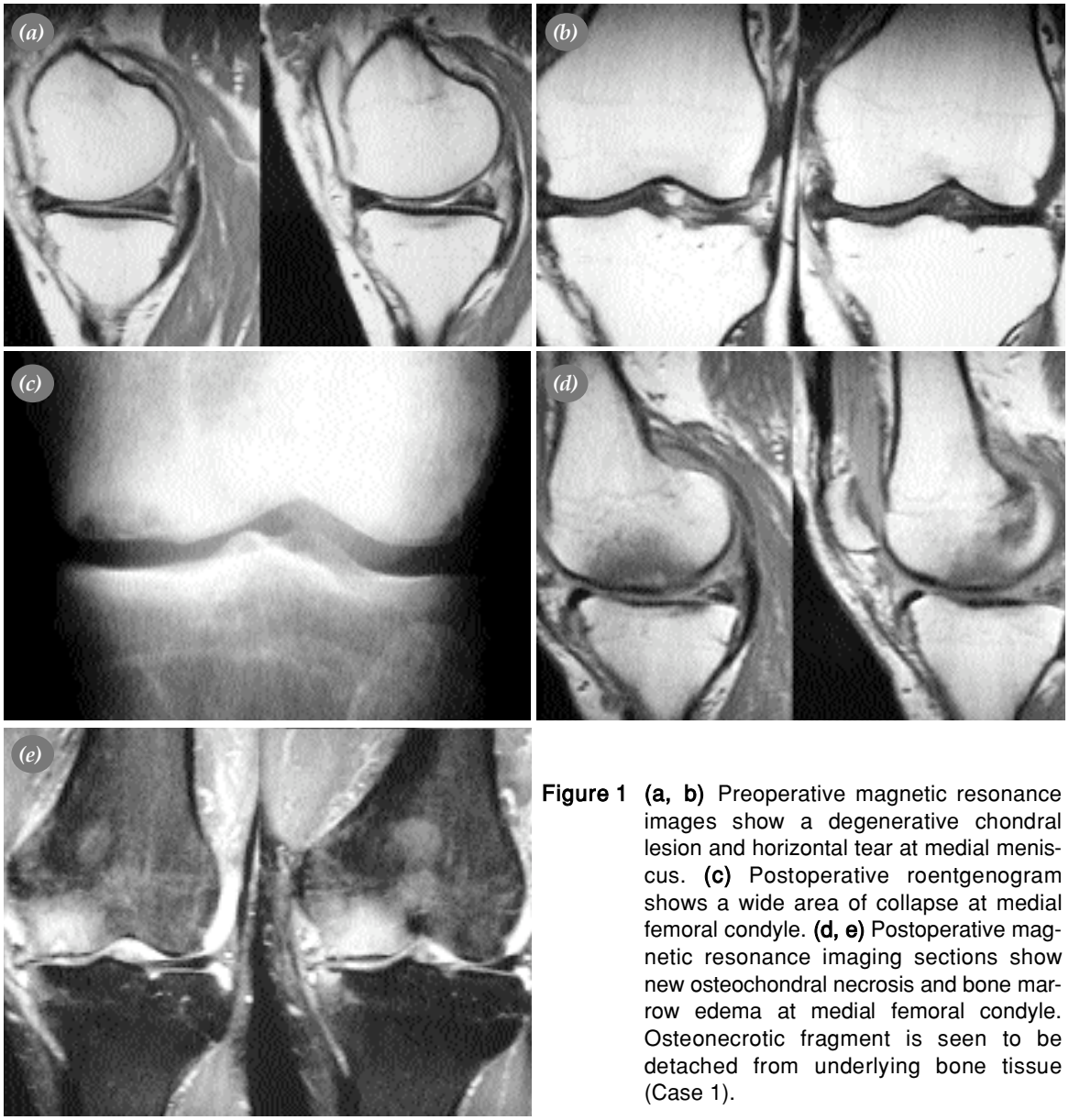

Figure 1 **(a, b)** Preoperative magnetic resonance images show a degenerative chondral lesion and horizontal tear at medial meniscus. **(c)** Postoperative roentgenogram shows a wide area of collapse at medial femoral condyle. **(d, e)** Postoperative magnetic resonance imaging sections show new osteochondral necrosis and bone marrow edema at medial femoral condyle. Osteonecrotic fragment is seen to be detached from underlying bone tissue (Case 1).

formed 2 months after the beginning of his symptoms was reevaluated and a mild degenerative chondral lesion on the medial compartment with a horizontal medial meniscus tear was detected (Figure 1a,b). There were no signs of bone marrow edema resembling early osteonecrosis. In our clinic, ragiography of the left knee revealed typical osteonecrosis signs with a large collapse area on the medial femoral condyle (Figure 1c). In the new MRI, a large area of osteochondral necrosis, detached from the medial femoral condyle, was detected. There was also diffuse edema around the bony crater (Figure 1d,e). A second arthroscopic procedure was performed and the osteonecrotic fragment was excised. Microfracture was performed for the remaining crater.

Case 2– A 34 year-old male patient was admitted to our clinic with a 3-week history of sudden knee pain which had been started with routine daily activity. The patient had a history of arthroscopic partial medial menisectomy 4 years ago in an outpatient clinic. In the physical examination, the patient had a localized pain on the medial femoral condyle. His radiographs were normal. Although he had no signs of osteonecrosis on MRI sections 4 years ago, the new MRI revealed osteonecrotic chondral lesion on the same compartment (Figure 2a,b). The patient was regularly controlled after then and conservatively treated.

Case 3– A 59 year old female patient with a 14 month-history of bilateral knee pain had been treat-

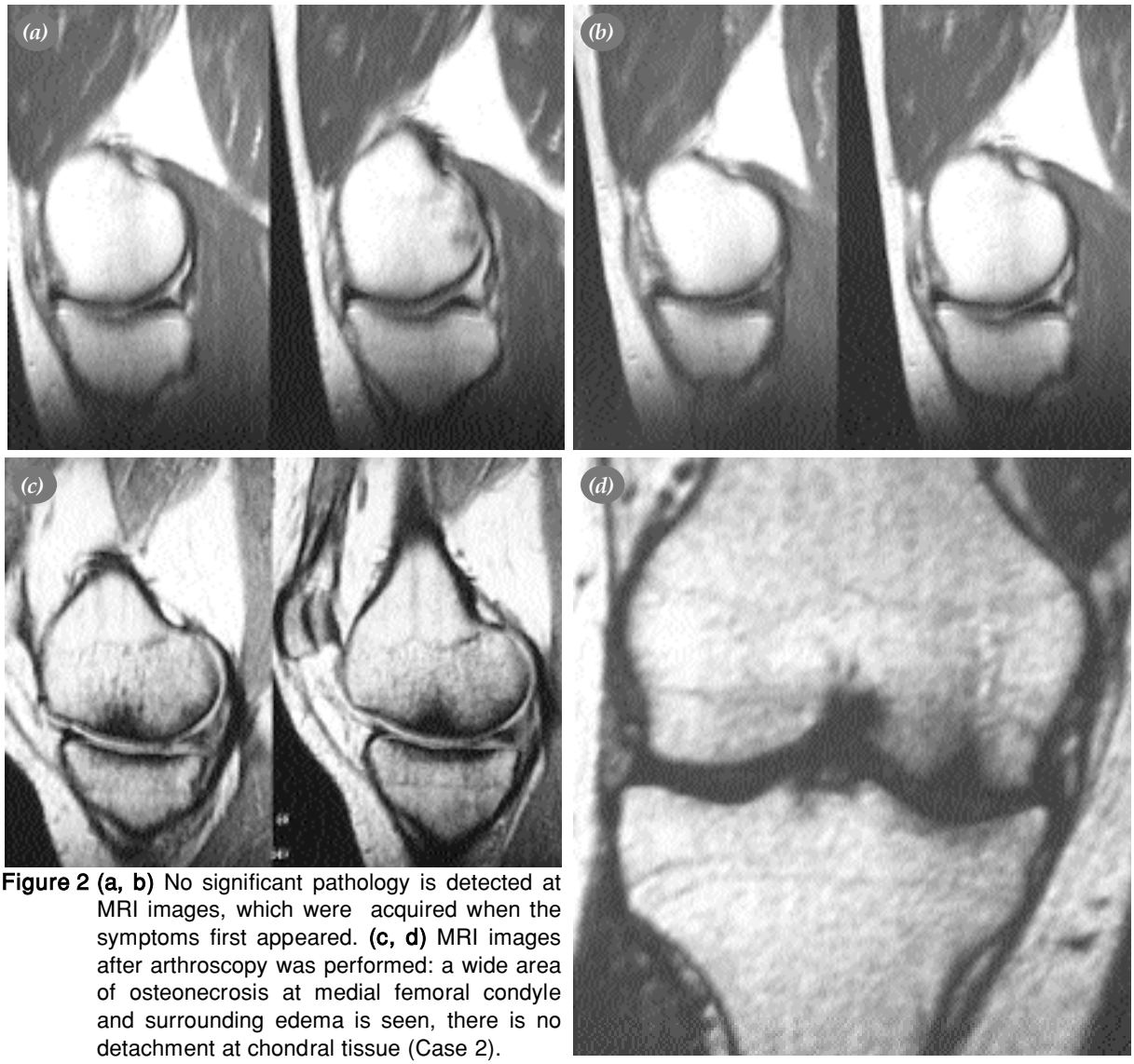

Figure 2 (a, b) No significant pathology is detected at MRI images, which were acquired when the symptoms first appeared. **(c, d)** MRI images after arthroscopy was performed: a wide area of osteonecrosis at medial femoral condyle and surrounding edema is seen, there is no detachment at chondral tissue (Case 2).

ed in a different center for the diagnosis of early gonarthrosis. In the follow-up, she had had no pain relief. MRI had been performed and revealed a degenerative medial meniscus tear (Figure 3a,b). For this reason, she had undergone arthroscopic partial menisectomy in the same center 8 months ago. After 2 months postoperatively, a severe knee pain had been started. As she had had no benefit from physical treatment and intra-articular hyaluranic acid injection, she was admitted to our clinic 3 months postoperatively. She had a severe medial femoral condylar pain and swelling. Her preoperative MRI was reevaluated and only a degenerative meniscal tear with minimal osteoarthritis was detected. On the other hand, her postoperative MRI performed 2 months after surgery revealed a diffuse medial femoral condylar edema and subchondral osteonecrosis (Figure3c,d). The patient was treated conservatively by non-weight bearing for 6 weeks.

Case 4– A 73-year old female patient had been treated conservatively for gonarthrosis by nonsteroidal anti-inflammatory drugs in an outpatient clinic. As her complaints continued 2 months after, an MRI had been planned and revealed minimal arthritic changes (Figure 4a,b). She had undergone arthroscopic debridement and thermal-energy chondroplasty. After surgery, she had a short period of pain relief lasting for one month only. As she had had no benefit from the physical treatment and intra-articular hyaluranic acid injection, the patient was admitted to our clinic 4 months after surgery. She had severe pain while walking and at rest. On physical examination, she had a general tenderness on her knee with a mild effusion. Radiographs revealed only minimal arthroses. A new MRI was performed and a 3x2 cm of osteonecrotic area on the medial femoral condyle was detected (Figure4c,d) and she was conservatively treated.

Case 5– A 78-year old male patient who had mild knee pain for a long time had admitted to an outpatient clinic with a sudden increase of his pain. Three days later, MRI was planned and a vertical degenerative meniscal tear was detected. At the same time, a small subchondral lesion was also seen on MRI but it was ignored (Figure 5a,b). Arthroscopic menisectomy had been performed but as the patient's complaint had not

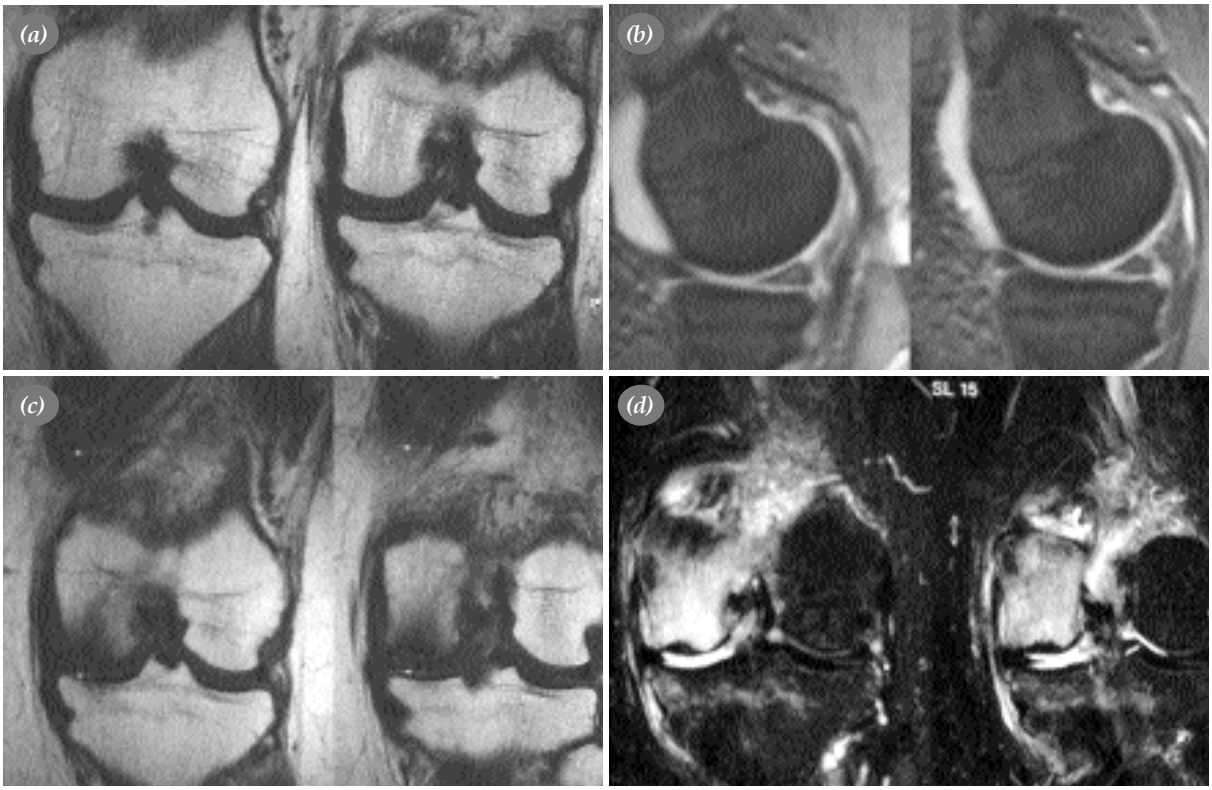

Figure 3. (a, b)) Preoperative magnetic resonance images show early signs of osteoarthritis and degenerative meniscus tear at medial meniscus posterior horn. **(c, d)** MRI performed at the second month postoperatively shows an area of osteonecrosis at medial femoral condyle, surrounded by awide area of bone marrow edema (Case 3).

resolved with physical treatment and intra-articular hyaluranic acid injection, he was admitted to our hospital 3 months after surgery. He had a severe pain on medial femoral condyle and effusion. He also had severe night pain. On radiographs, he had collapse on medial femoral condyle (Figure 5c). MRI revealed diffuse bone marrow edema on medial femoral condyle and tibial plato (Figure 5d,e). As the patient did not want any additional surgery, he was conservatively treated. This patient's symptoms were probably due to osteonecrosis from the beginning; but as the MRI performed immediately after his complaints revealed no definite sign of osteonecrosis, it had been ignored.

Discussion

The real incidence of osteonecrosis after arthroscopy is not exactly known. Most of the studies in the literature are as case reports. In his study, Santorini [2] et al reported the incidence as 0.1%.

The most important thing for the osteonecrosis after arthroscopic chondral or meniscal surgery is to make clear the relationship between surgery and osteonecrosis. On animal models, it was reported that, for the visualization of osteonecrosis, MRI must be performed at least 4 weeks after the onset of the complaints.[16] Johnson et al. reported this duration as 6 weeks for humans. [9] For the confirmation of the relationship between arthroscopy and osteonecrosis, the preoperative MRI must be performed at least 4 weeks before the onset of the symptoms and must have no signs of osteonecrosis. On the other hand, MRI before 4 weeks can result in wrong diagnosis as the osteonecrosis can not be seen.

The duration of osteonecrosis development after arthroscopy is not clear. A case of osteonecrosis after 9 months after arthroscopy had been reported in the literature.[5] In our study, case number 2 had osteonecrosis on the same compartment of which surgery had been performed 4 years after his initial surgery. In the pathogenesis of osteonecrosis, the most important factor is the microfractures due to the abnormal weight transfer on the medial femoral condyle. As a result, we supposed that, for the

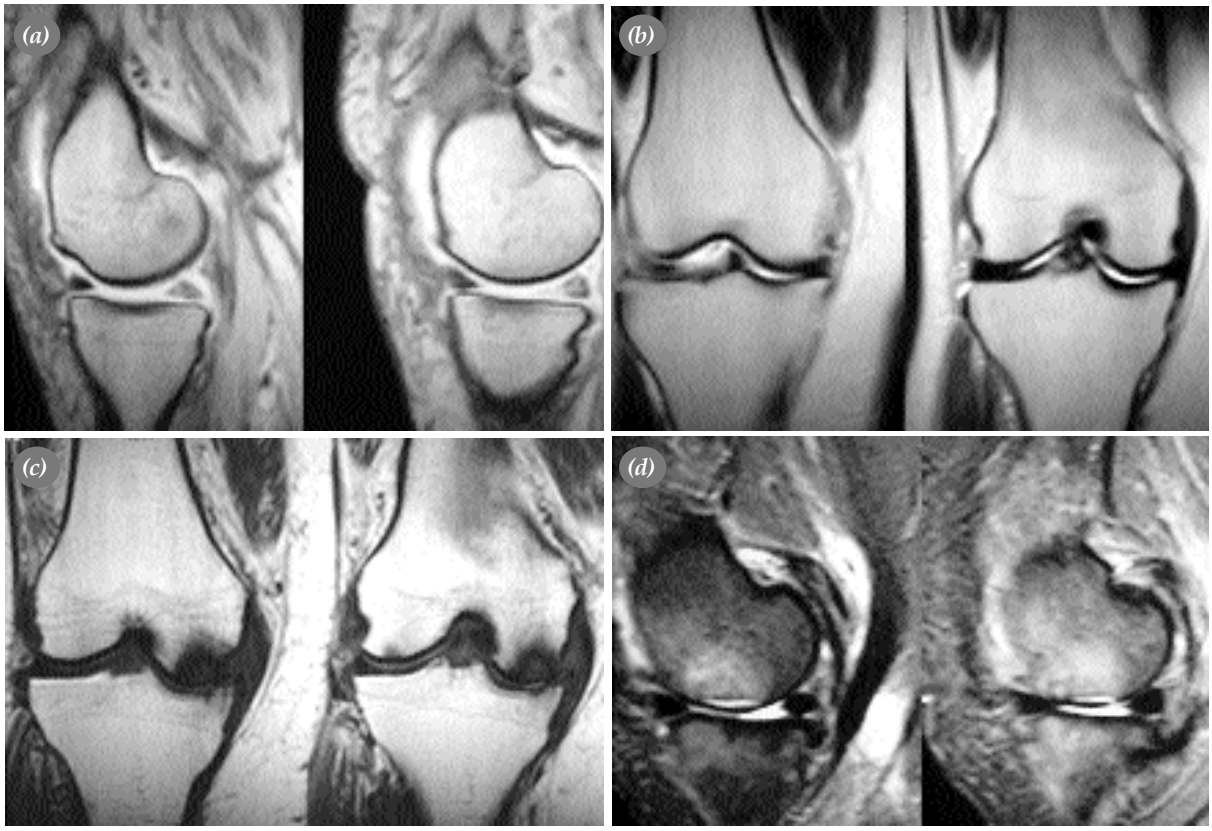

Figure 4. (a, b) Preoperative MRI images show a degenerative tear at medial meniscus posterior horn and mild arthritic changes. **(c, d)** Postoperative MRI images show an area of osteonecrosis, 3x2 cm. wide, at medial femoral condyle and surrounding edema. (Case 4).

patients with no risk factors, the reason for osteonecrosis on the same compartment is the arthroscopic meniscal surgeries.

Arthroscopic meniscal and chondral surgeries are commonly used treatment methods for the knees with degenerative arthritis. Osteonecrosis should be kept in mind for patients with degenerative chronic arthritis who had severe and sudden worsening of knee symptoms without any trauma history. These patients had also severe knee pain at rest. Their MRI most commonly demonstrates a meniscal tear. If T2-wheigted images are not seen or if there aren't any definite bone edema on any MRI sections, one can think the reason for the complaints due to degenerative changes. In these patients, arthroscopic meniscal or chondral surgery can yield to worsening of the knee symptoms resulting in early collapse. Our fifth case was an example of this. For a degenerative knee joint, before any arthroscopic procedure, the source of the knee pain must be carefully determined and a silent osteonecrosis must be kept in mind.

In some of the studies about osteonecrosis in the literature, MRI was performed a few weeks later than the onset of symptoms and a possible early asymptomatic osteonecrosis was misdiagnosed. [3,10,17] In these studies, it is hard to say the reason for

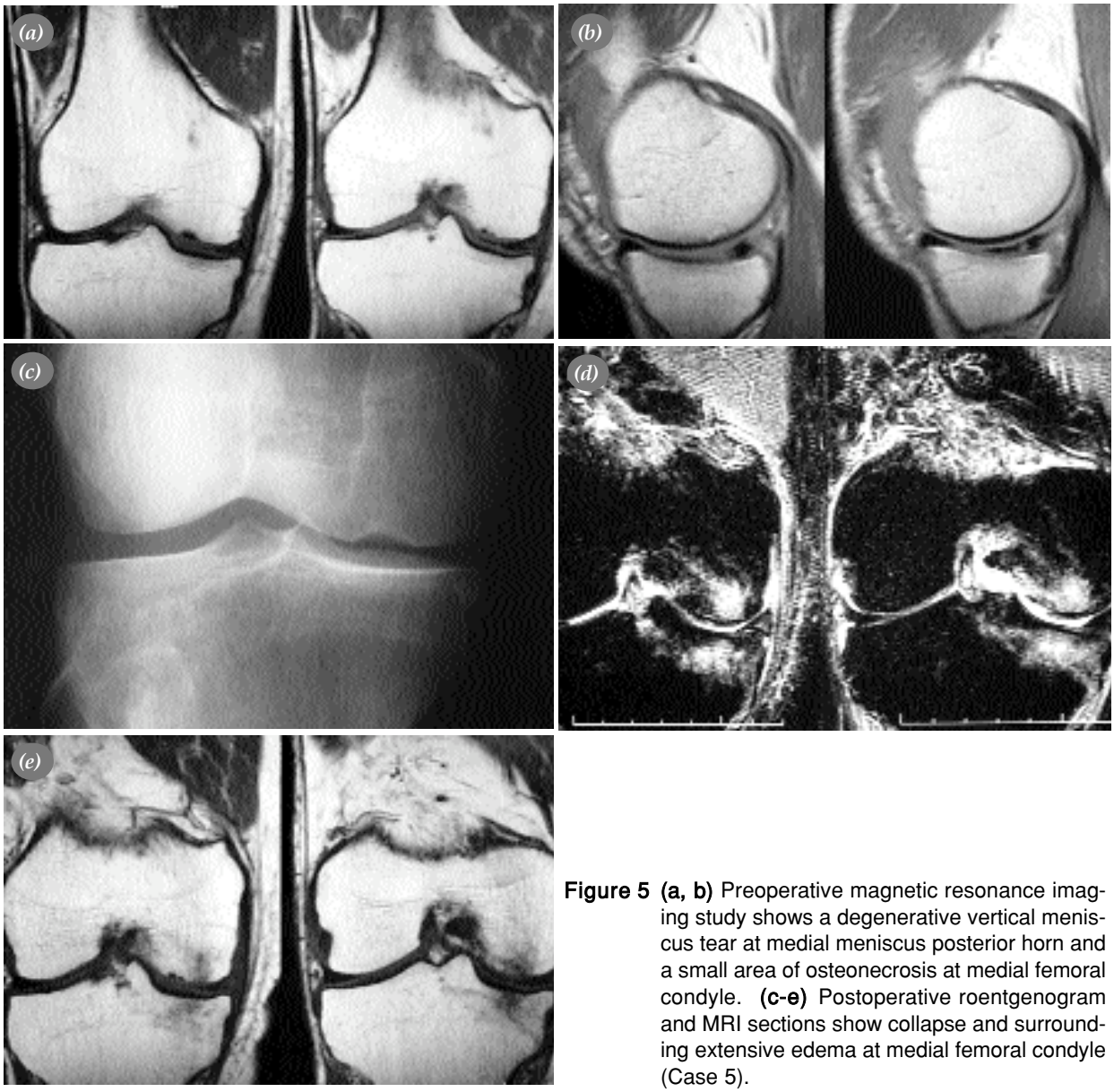

Figure 5 **(a, b)** Preoperative magnetic resonance imaging study shows a degenerative vertical meniscus tear at medial meniscus posterior horn and a small area of osteonecrosis at medial femoral condyle. **(c-e)** Postoperative roentgenogram and MRI sections show collapse and surrounding extensive edema at medial femoral condyle (Case 5).

osteonecrosis is arthroscopy. On the other hand, there are some case reports in the literature which had no signs of osteonecrosis on MRI images performed at least 6 weeks after the onset of symptoms. In these studies, patients had osteonecrosis after arthroscopy confirming the relation between arthroscopy and osteonecrosis.[9] Our first four cases are suitable to these criteria.

The etiopathogenesis of osteonecrosis after mechanical devices used meniscal or chondral knee surgeries is not clearly identified. In a study by Santori et al., it was reported that, the abnormal load transfer after menisectomy, leading to chondral injury, inflammation and edema, was the major cause for osteonecrosis via increasing the intraosseous pressure. In an another theory, the reason for osteonecrosis was reported as the abnormal load transfer after menisectomy in a degenerated knee leading to microfractures and abnormal blood circulation.[9,10] In both of the situations, synovial fluid leaking intramedullarly by chondral injury or fracture results in a pressure increase leading to osteonecrosis. [1,2,4]

Another factor in the etiopathogenesis is the use of laser energy while arthroscopy. The Holmium and neodymium YAG lasers are commonly used while meniscal surgeries especially for the patients with narrow joint spaces. Their purposes are excision of the meniscus and countouring of the joint surface. In the year 90's, there were a series of cases, reported, in which osteonecrosis developed after YAG lasers. [4,5,18,19] The reason for osteonecrosis after laser application was reported as the thermal energy leading to microcirculation defects. In addition, photoacustic effect due to the sudden recycling of the solid and liquid forms into gas form in milliseconds result in pressure waves leading to osteonecrosis. In some experimental studies, it was stated that, the effect of photoacoustic energy was dose dependent and a total of 125 Joule of energy was enough for a subchondral injury. In two of the cases in our study (case 1 and case 3), they had a history of athroscopic surgery with holmium YAG laser. After description of necrosis effect of the high dose YAG laser, the safe zones for laser chondroplasty had been started to analyzed.[20] In a study of 504 cases, there was no osteonecrosis with the non contact and tangential application of laser energy under 1 joule.[21] On contrary, in experimental studies, it was shown that, even the safe doses of thermal energy had resulted in chondrocyte death, matrix differentiation and chondral shear.[22] Arthroscopic laser chondroplasty is still a matter of debate so if it will be used for chondroplasty, the possible risks and long term effects has to be explained to the patient.

Patients with osteonecrosis have most often a typical history. After a short period of pain relief, patients again started to have a feeling of pain and swelling. Night pain and pain at rest are also present. If an osteochondral lesion is detached, mechanical symptoms like as locking can be seen. The symptoms are most commonly localized to the compartment of which the surgery was performed. If the symptoms do not change after arthroscopy, then an early grade, silent osteonecrosis which could not be seen on preoperative MRI should be kept in mind. In physical examination, effusion and limited range of motion can be seen, but the most important sign is the pain of the effected femoral condyle by palpation. Provocative tests like MCMurray can also be positive on the effected side.

If there is no collapse, direct X-rays are not different from the ones taken preoperatively. On the other hand, if there is a collapse of the subchondral bone on the effected side, there can be flattening of the condylar convexity, a typical radiolucent area and sclerosis on the radiographs. In the late stages of necrosis, there can also be seen osteochondral detachments.

MRI is a more sensitive imaging technique. It can detect a possible osteonecrosis earlier; can show the size and the relation of the chondral lesion better. [8] Spontaneous osteonecrosis is seen as focal areas with low signal intensity on T1 and T2 weighted MRI images. Depending on the thickness of the osteochondral lesion, a crescent sign of detachment can also be seen on MRI. On T2 weighted, fat-supressed images, the necrotic area is seen as hypointense, surrounding bone marrow edema is seen as a bigger hyperintense lesion advancing into the metaphyseal region.[23] The size of the lesion can be more precisely detected in these MRI sections. MRI after arthroscopic surgeries must be carefully evaluated for an osteonecrotic lesion. Kobayashi et al. [8] reported 34% of signal intensity changes on both tibial and femoral subchondral bones in 93 cases of isolated meniscal excision. Although the

severity of these signal intensity changes which are not recognized preoperatively increases as the size of the meniscal excision increases, they are not related with the symptoms of the patient. Nevertheless, the question of "Does the signal intensity changes localized less than one and a half of the femoral condyle result of the surgical trauma leading to edema or is it a result of early osteonecrosis?" is not clearly answered. Studies in the literature can not give any data about the prognosis of patients as their follow-up is not enough. For the knees with spontaneous osteonecrosis, it is accepted that, the risk for progression is proportional with the size of the condylar osteonecrosis. For this reason, while some of the signal intensity changes can heal spontaneously, some can progress into a real osteonecrosis.

The histological diagnosis of osteonecrosis can only be made for patients undergoing surgery. For this reason, as most of the patients are conservatively treated, histological diagnoses can not be achieved for all osteonecrosis. In most of the studies in the literature, diagnosis had been made by either radiographies or MRI.[1-3,6,9] In our study, apart from the case number 1, whose necrotic fragment was excised intraoperatively, all diagnosis was made by using different imaging techniques. As these techniques clearly diagnosed the ostenecrosis, we did not need histopathological confirmation for all cases.

There isn't any well-defined treatment protocol for osteonecrosesis in the literature because a great amount of the studies are as case reports. For most of the patients, a conservative treatment including non-weight bearing by crane or crutches, non-steroidal anti-inflammatory drugs, cold application and quadriceps rehabilitation can be enough for the follow-up. On contrary to hip osteonecrosis, for the knee osteonecrosis, conservative treatment can be applied. In a study by Ecker and Lotke [24], it was stated that, surgical treatment can be chosen for patients with idiopathic osteonecrosis who could not be conservatively treated in a period of 6 months. For precollapse lesions, arthroscopy assisted or open core decompression can be used. If the lesion has collapsed or detached, one of the treatment alternatives including arthroscopic or open chondral reconstruction techniques, proximal tibial osteotomy or arthroplasty must be chosen.[25]

As a conclusion, development of osteonecrosis after arthroscopic meniscal and chondral knee surgery is a rare but serious complication. For especially old patients with degenerative arthritis, it must be kept in mind that, a silent osteonecrosis without any signs on imaging methods can be present before the first surgery. In cases with worsening knee symptoms after arthroscopic surgery, MRI must be used for a detailed evaluation. Lesions with metaphyseal edema and subchondral necrosis without any collapse can be regressed spontaneously by conservative treatment. After the development of collapse, more complicated surgical procedures must be used. If thermal energy will be used for the chondral surgery, it must be used in the safe parameters and the risks and possible complications must be clearly identified to the patient.

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