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The relationship between MRI findings and duration of symptoms in transient osteoporosis of the hip

Geçici kalça osteoporozunda MRG bulguları ile semptomların süresi arasındaki ilişki

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Amaç: Geçici kalça osteoporozlu (GKO) hastalarda manyetik rezonans görüntüleme (MRG) bulguları ile semptomların süresi arasındaki ilişki araştırıldı.

Çalışma planı: Konservatif tedavi ile semptomları tamamen düzelen KGO'lu dokuz hastanın (7 erkek, 2 kadın; ort. yaş 45; dağılım 31-54) MRG görüntüleri iki radyolog tarafından geriye dönük ve birbirinden bağımsız olarak iki kez değerlendirildi. İncelemelerde subkondral hipointens çizgi (kırık) varlığı araştırıldı; subkondral kırık alanı hesaplandı ve kemik iliği ödeminin yaygınlığı A, B, C ve D olmak üzere dört grupta sınıflandırıldı. Olgularda MRG öncesi ve sonrası semptomların süresi kaydedildi ve semptomların süresi ile MRG bulguları arasındaki ilişki değerlendirildi.

Sonuçlar: Gözlemci içi ve gözlemciler arası korelasyon katsayıları iki radyolog için ölçümlerin uyumlu olduğunu gösterdi. Yedi olguda subkondral kırık izlendi. Bu olguların ikisinde grup B, ikisinde grup C, üçünde grup D kemik iliği ödemi saptandı; kırık alanı ise sırasıyla ortalama 8.5 mm^2, 18.2 mm^2 ve 29.7 mm^2 idi. Subkondral kırıklı olgularda semptomların başlangıcı ile MRG incelemesi arasındaki süre ortalama 1.8 ay (dağılım 1-4); MRG çekimi ile yakınmaların düzelmesi arasındaki süre ise grup B'de ortalama 4 ay, grup C'de 5 ay, grup D'de 6.6 ay bulundu. Benzer düzeyde kemik iliği ödemi bulunan olgularda subkondral kırık varlığının ve kırık alanındaki artışın iyileşme süresi uzattığı görüldü. Subkondral kırık alanı ise kemik iliği ödeminin yaygınlığı ile artış gösteriyordu. Subkondral kırık bulunmayan iki olgunun birinde grup A, diğerinde grup D kemik iliği ödemi izlendi; bu olgularda semptomlar MRG incelemesinden sonra sırasıyla bir ay ve üç ay içinde kayboldu.

Çıkarımlar: Bulgularımız, GKO'da femur proksimal kesiminin farklı oranlarda etkilendiğini; klinik bulguların düzelme süresi ile subkondral kırık varlığı, boyutu ve kemik iliği ödeminin yaygınlığı arasında yakın ilişki olduğunu göstermektedir.

Anahtar sözcükler: Femur başı/patoloji; femur boynu/patoloji; kalça kırığı; kalça eklemi/radyografi; manyetik rezonans görüntüleme; osteoporoz/komplikasyon; zaman faktörü.

Objectives: We investigated the relationship between magnetic resonance imaging (MRI) findings and duration of symptoms in patients with transient osteoporosis of the hip (TOH).

Methods: The study included nine patients (7 men, 2 women; mean age 45 years; range 31 to 54 years) with TOH, whose symptoms disappeared after conservative treatment. MRI scans of the patients were retrospectively and independently reviewed twice by two radiologists to assess the presence of a subchondral hypointense fracture line, to calculate the area of subchondral fracture, and to classify the extent of bone marrow edema into four groups as A, B, C, and D. Duration of symptoms before and after MRI was recorded and associations between symptom duration and MRI findings were assessed.

Results: The intraobserver and interobserver correlation coefficients showed an excellent agreement for both radiologists. A subchondral fracture was detected in seven patients; of whom, bone marrow edema corresponded to group B, C, and D in 2, 2, and 3 patients, and the mean fracture areas were 8.5 mm^2, 18.2 mm^2, and 29.7 mm^2, respectively. The mean symptom duration in these patients before MRI was 1.8 months (range 1 to 4 months), and relief of symptoms after MRI took 4, 5, and 6.6 months in groups B, C, and D, respectively. In the presence of a similar extent of bone marrow edema, the occurrence of subchondral fracture and increase in the fracture area were associated with delayed relief of symptoms. Subchondral fracture area was also correlated with the extent of bone marrow edema. Two patients without a subchondral fracture had bone marrow edema of group A and D, and the symptoms disappeared in one month and three months following MRI, respectively.

Conclusion: Our results show that the extent of involvement of the proximal femur may vary in TOH, and that time to clinical improvement may be closely related to the presence and size of subchondral fracture, and the extent of bone marrow edema.

Key words: Femur head/pathology; femur neck/pathology; hip fractures; hip joint/radiography; magnetic resonance imaging; osteoporosis/complications; time factors.

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Transient Osteoporosis of the Hip (TOH) is a rare self-limited condition of unknown etiology (recovers in about 4-9 months with symptomatic therapy) causing hip pain characterized by localized osteopenia.[1] While numerous literature reports evaluating the clinical, radiological [2,3,4,5,6,7] and histopathological [8,9] characteristics of TOH, studies investigating the relation between magnetic resonance imaging (MRI) findings and duration of symptoms are rather insufficient.[6] In addition, not all parameters with possible effect on the recovery process are grouped and evaluated in those studies. The aim of the present study is to investigate and reveal MRI findings with possible effect on the recovery process of TOH.

Material and method

The MRI images and clinical records of patients complaining of hip pain referred to our department between 05/09/2000 – 29/03/2007 were retrospectively evaluated. Cases with hip septic arthritis, femoral head contusion, fracture, insufficiency fracture, benign or malignant mass (primary or secondary) of proximal femur, avascular femoral head necrosis, and patients with preliminary diagnosis of TOH or early stage osteonecrosis with nonresolving clinical and radiological findings during the follow-up period, and TOH patients that underwent decompression surgery or those administered antiresorptive agents aiming to shorten the clinical recovery period[10] were not included in the study. Only 9 TOH patients, complaining of hip pain, with no history of trauma and infection, with normal laboratory data, with proximal femoral bone marrow edema finding on the MRI images and who recovered totally with conservative treatment were included in the study. Seven were males, 2 were females, one of them being pregnant. The mean age was 44.8 years, ranging between 31 – 54. Hip joint MRI findings and duration of symptoms prior to and following MRI were evaluated for all patients. Magnetic resonance (MR) investigations were carried out with a 1.0 Tesla (signa, GE Medical System, Milwakee) machine using body coil. Despite obtaining coronal T_2-weighted (W) spin echo (SE), axial fat-suppression T_2-W SE, sagittal T_1-W SE images, evaluation was based mainly on coronal plane T1-W SE (TR/TEms: 560/20, slice range: 5mm, FOV 37 cm, matrix:256x256) and coronal plane fat-suppression T_2-W fast SE (TR/TEms: 3000/90, slice range: 5mm, FOV 37cm, matrix: 256x256, ETL: 7) images.

Bone marrow edema (low signal intensity in the marrow of the upper femoral epiphysis and metaphysis on T_1- weighted images (WI) with matching high signal intensity on T_2-WI) was classified into 4 groups depending on the extention. Group A: edema limited to the femoral head, Group B: edema extending to the femoral neck, Group C: edema of less than 1 cm of intertrochanteric region on coronal plane images, Group D: edema of more than 1 cm of intertrochanteric region on coronal plane images. The bone marrow edema extent was measured in the most large edema area on the fat-suppression coronal T_2-WI. The subchondral hypointense line (subchondral fracture), on the other hand, was seen in the T_1-WI concordant with a low signal intensity in the subchondral area parallel to the femoral head.[11] The area of the subchondral hypointense line was calculated (Area = thickness x length) in its most large appearing region on the coronal T_1-WI. The duration of the complaints of the patients prior to and following MRI was noted from their clinical records or, where records were insufficient, by contacting them via phone. The MRI's of all patients were evaluated twice by two radiologists independently, evaluations being 3 weeks apart. Images were firstly evaluated for presence of a hypointense subchondral line and the patients were accordingly subdivided into two groups: with subchondral fracture and without subchondral fracture. The MRI images then were evaluated with regard of the type of the bone marrow edema, area of the subchondral fracture, presence of intraarticular fluid, and whether subchondral area is spared or not by the edema. Intraobserver and interobserver reliance analyses were carried and the correlation coefficient was calculated for the MRI findings (type of the bone femoral head edema, presence of intraarticular fluid, and whether subchondral area is spared or not by the edema) of the two radiologists. Wilcoxon Signed Rank Test was used to analyze the differences in the calculation of the subchondral fracture area. In addition, in cases of difference in the evaluation of the findings except the subchondral fracture area by the two observers, final decision was met by obtaining a third observer's opinion. Regarding the subchondral fracture area, the mean value of all measurements was obtained. The frequency of MRI findings was calculated and the relation to begin of symptoms and end of symptoms was evaluated, accordingly. But statistical evaluation could not be accomplished due to insufficient sample size.

Results

The initial evaluation by the first radiologist revealed presence of a subchondral hypointense line in 7 cases, while being not observed in the remaining 2 cases. Bone marrow edema type frequency was as follows: group D (44.4%) in 4 patients, group C in 2 patients (22.2%), group B in 2 patients (22.2%) and group A in one patient (11.1%). Intraarticular fluid was observed in all 9 cases (100%). Sparing of subchondral area from edema was observed in 1 patient (11.1%). The initial evaluation by the second radiologist revealed presence of a subchondral hypointense line in 7 cases, while being not observed in the remaining 2 cases. Bone marrow edema type frequency was as follows: group D (44.4%) in 4 patients, group C in 2 patients (22.2%), group B in 2 patients (22.2%) and group A in one patient (11.1%). Intraarticular fluid was observed in all 9 cases (100%). Sparing of subchondral area from edema was observed in 1 patient (11.1%). The second evaluation by the first radiologist revealed presence of a subchondral hypointense line in 7 cases, while being not observed in the remaining 2 cases. Bone marrow edema type frequency was as follows: group D (33.4%) in 3 patients, group C in 3 patients (33.3%), group B in 2 patients (22.2%) and group A in one patient (11.1%). Intraarticular fluid was observed in all 9 cases (100%). Sparing of subchondral area from edema was not observed in any of the cases. The second evaluation by the first radiologist revealed presence of a subchondral hypointense line in 7 cases, while being not observed in the remaining 2 cases. Bone marrow edema type frequency was as follows: group D (44.4%) in 4 patients, group C in 2 patients (22.2%), group B in 2 patients (22.2%) and group A in one patient (11.1%). Intraarticular fluid was observed in all 9 cases (100%). Sparing of subchondral area from edema was observed in 1 patient (11.1%). The intraobserver and interobserver correlation coefficient of the two radiologists with regard to their evaluation of the type of the femoral head edema, presence of intraarticular fluid and sparing of the subchondral area by the bone marrow edema was 99.9%, indicating concordant evaluations. There was no difference in the calculation of subchondral fracture area with regard to intraobserver and interobserver evaluation ($p<0.735$). Group D bone marrow edema was the most frequently encountered finding in the study group. Subchondral hypointense line was observed in 7 cases, while being not observed in the remaining 2 cases. Bone marrow edema types of the cases with present subchondral line were as follows: group B in 2 cases (Figure 1), group C in 2 cases (Figure 2), and group D in 3 cases (Figure 3). The mean area of the low signal intensity subchondral fracture was 8.4mm^2 in the group B cases, 18.1mm2 in the group C cases, and 29.7mm^2 in the group D cases. The time elapsed between onset of symptoms and the MRI evaluation was 2 months for two, and 1 month for one of the cases in Group D; one month for one, and 2 months for one of the cases in Group C; one month for one, and 4 mon-

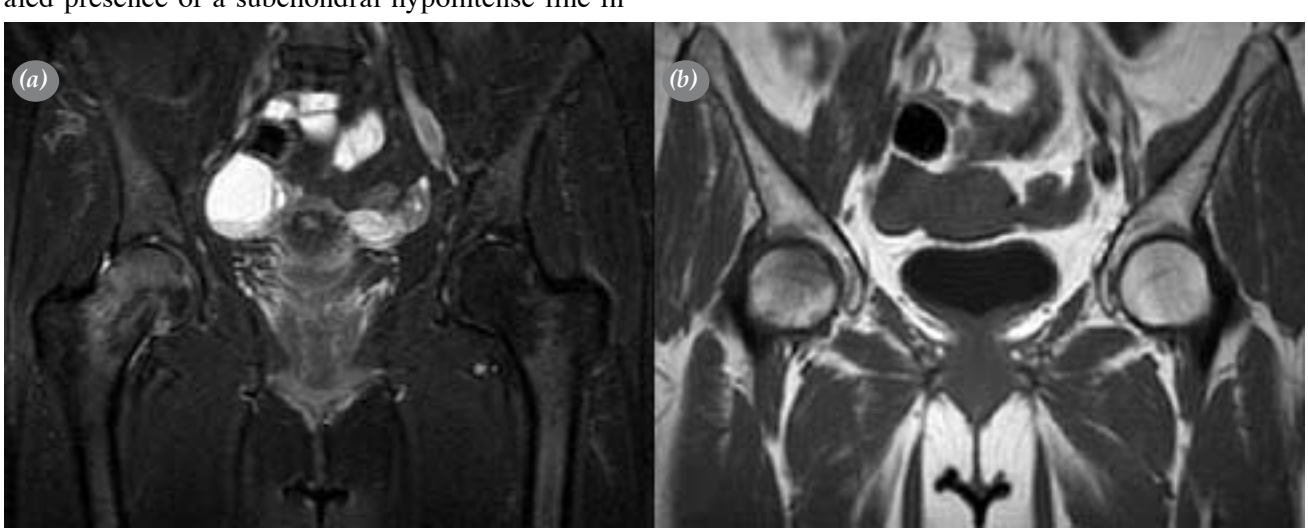

Figure 1. The appearance of bone marrow edema affecting the femoral neck concordant with group B bone marrow edema in the coronal fat-suppression T_2-weghted hip MRI, **(a)** of a 44-year old female patient whose symptoms recovered 4 months after MRI was obtained. In addition, a subchondral fracture attracts attention, as visualized in the T_1-weghted image. **(b)** of the same patient.

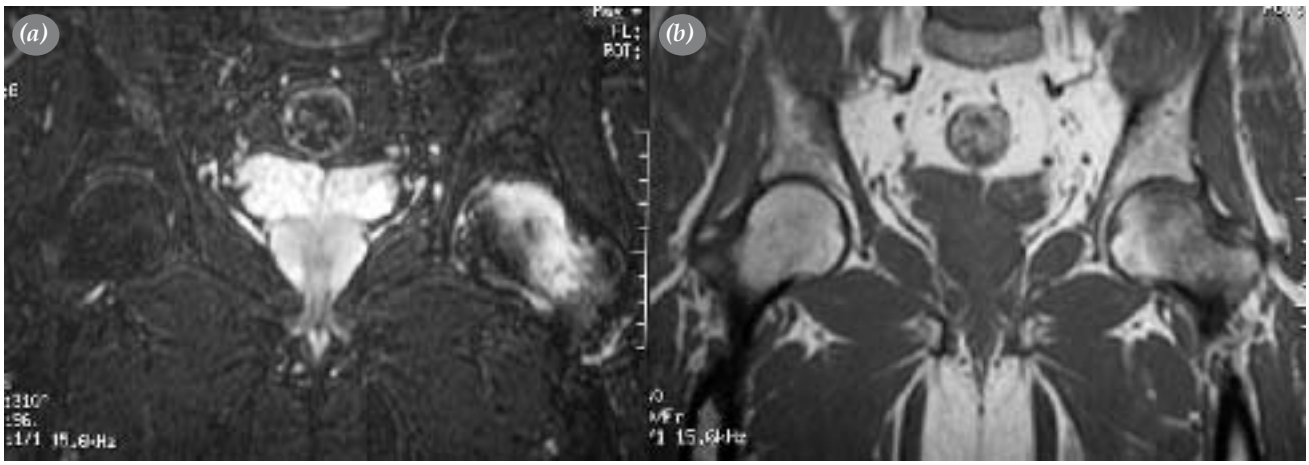

Figure 2. A less than 1 cm intertrochanteric region bone marrow edema is observed in this T_2-weighted fat-suppression coronal hip MRI, **(a)** of a 50-year old male patient. The T_1-weighted image. **(b)** of the same patient demonstrates a subchondral fracture line appearing as a hypointense line.

ths for one of the cases in Group B, respectively; while the duration of symptoms until full recovery following MRI was 4 months in group B, 5 months in group C, and 6.6 months in group D, respectively. The recovery period was 5 months for the two of the Group D cases with similar fracture line areas (mean: 19.9mm^2), while being 9 months for the case with a fracture line area of 49.5mm^2. The Group B and Group C cases, on the other hand, had similar fracture line areas. On the other hand, the type of edema observed in the 2 cases with no subchondral fracture were group A (Figure 1), and group D. The time period between onset of symptoms and the MRI evaluation of these cases was 5 months for the Group A case, and 2 months for the Group D case, respectively. The duration of symptoms until full recovery following MRI was 1 month in group A, and 3 months in group D, respectively. Intraarticular fluid was observed in the MRI's of all patients, while in one case the subchondral area was observed to be spared by the bone marrow edema.

Discussion

Group D marrow edema was the most frequently observed type, followed by group B=C, and group A, respectively. In the two cases with bone marrow edema only, the recovery period of the with group A edema was 1 month, while being 3 months in the one with the group D edema. The recovery period of patients with same level bone marrow edema was longer for those

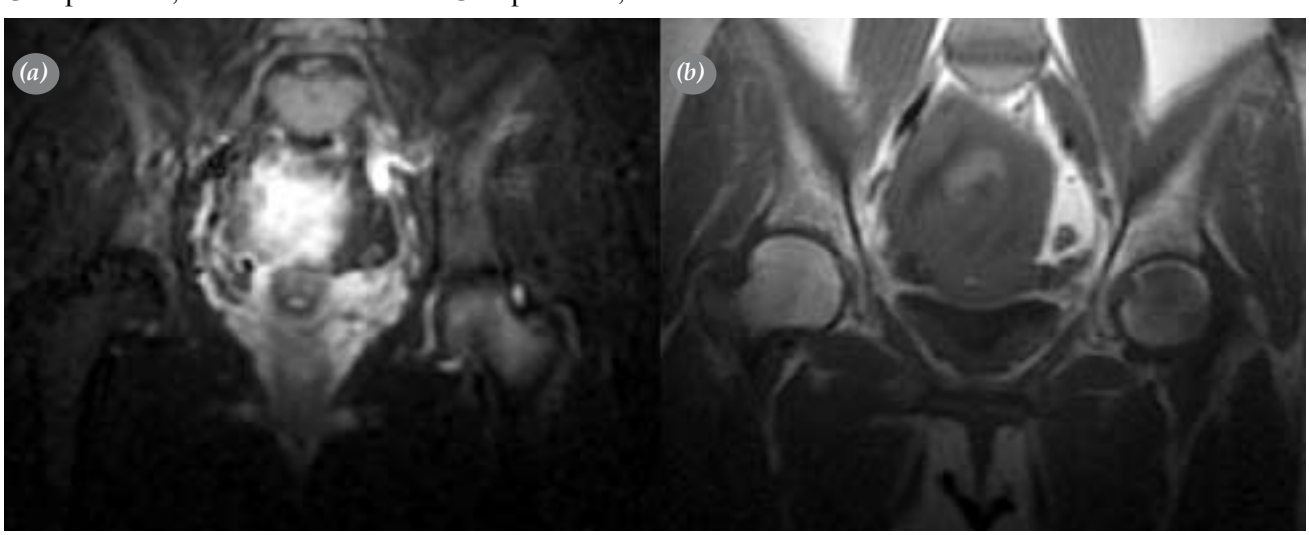

Figure 3. A group D bone marrow edema affecting more than 1 cm of the intertrochanteric region is observed in this T_2-weighted fat-suppression coronal hip MRI, **(a)** of a 30-year old pregnant patient whose symptoms recovered 9 months after MRI. A significant subchondral fracture attracts attention in the T_1-weighted MRI. **(b)** of the same patient.

Figure 4. Bone marrow edema limited to the femoral head is observed in this fat-suppression coronal T_2-weighted MRI obtained from a 49-year old male patient complaining of hip pain for 5 months. The subchondral area is noticed to be spared by the femoral head bone marrow edema.

with accompanying subchondral fracture when compared to those without subchondral fracture. In addition, the recovery period increased parallel to increased area of the subchondral fracture in patients with same level bone marrow edema. On the other hand, the area of the subchondral fracture increased parallel to the extent of the bone marrow edema. The observation that no relation was found between the extents of the edema and begin of symptoms lead to the assumption that proximal femoral area may get affected by the disease to a varying extent. The direct relation between the extent of proximal femoral edema and the duration of the recovery period supports the observation that recovery duration may last longer with more extensive edema. Similarly, a direct relation was observed between the presence and extent of subchondral fracture and the duration of the recovery period, indicating that larger fracture area may lead to longer recovery period. The close relation between the subchondral fracture area and the extent of the proximal femoral bone marrow edema supports the assumption that more extensive edema may lead to increased regional femoral osteoporosis, which in turn weakens the bone structure eventually facilitating the subchondral fracture. Transient osteoporosis of the hip is a rare disorder characterized by bone marrow of the hip joint and increased bone turn-over rate (resorption and synthesis). The etiology of TOH remains unknown, but it is assumed to result from activation of femoral head osteoclasts by unknown stimulators.[12] In their study, Malizos et al.[6] obtained results similar to the results of our study, namely: there were differences in the extent of the bone marrow edema affecting the proximal femoral region among individuals with same duration of symptoms. This finding indicates the variable quantity of affected osteoclasts on an individual bases in TOH patients, which was not discussed in the literature to the best of our knowledge. In the early course of TOH a decrease in bone mass is observed secondary to osteoclastic activity, which is later replaced by new bone formation. Histopathologically, in the early course of the disease (2 months or less) bone resorption and necrosis are observed, while later in the course (mean of 5 months or more) new bone formation and bone build-up is observed.[8] Clinical findings are consistent with these findings and the clinical course of transient osteoporosis of the hip is divided into 3 periods. The initial period encompasses the first 1-2 months period and is characterized by increase in pain and dysfunction. The second period lasts about 2-4 months and initial symptoms and findings remain unchanged. The last period encompasses a 2-6 months period where pain gradually subsides and finally recovers.[13] Prior to this study, literature screening revealed no or limited number of studies investigating the variability in duration of the mentioned 3 periods or evaluating the relation between MRI findings and duration of symptoms.[6] In addition, total duration of symptoms in those studies was compared to MRI findings, but no grouping and evaluation of all parameters with probable effect on the recovery process was accomplished. The observations obtained from our study lead to the assumption that the variability in the durations of the 3 periods of TOH may be related to the variability of the bone marrow edema the secondary to this weakening of the bone tissue. Contrary to our study, Malizos et al. [6] reported no relation between extent of the bone marrow edema and duration of the symptoms in their study. This difference, in our opinion is due to the fact that Malizos et al.[6] did not group their cases with relation to presence of subchondral fracture line, and the fact that they assumed the symptoms' duration as the whole period from begin of symptoms until recovery, without classifying it basing on MRI. For example, to relate the symptoms of a patient who is occasionally in the recovery period during the MRI investigation to the bone marrow edema type would be erroneous. On the contrary, we tried to determine the duration of symptoms after the MRI and investigated the effect of the MRI findings on the recovery process in the period

after MRI was obtained. As a result, despite the limited number of cases, we found that the recovery time may increase parallel to the bone marrow edema extent of the proximal femoral region. The second MRI finding of our study affecting the clinical duration of recovery in TOH is the presence and extent of a subchondral fracture, the effect of which on symptoms' duration was not reported to be evaluated in the literature, previously. Comparing cases with same level bone marrow edema with and without a subchondral fracture revealed longer recovery period in the cases with fracture. In addition, the recovery period of the cases with the same level bone marrow edema and subchondral fracture was found to last longer parallel to the size of the fracture. As a result, based on these findings, in our opinion, the presence and size of subchondral fracture may also increase the recovery period in addition to the bone marrow edema. Even a minimal stress on the femoral head may cause subchondral fracture in the osteoporotic bone of transient osteoporosis of the hip. Thus, it is reasonable that the size of the subchondral fracture increases parallel to the weakened bone mass (with increase of bone marrow edema extent), as was observed in our study. There are only limited literature reports, however, where this relation is evaluated.[5] Contrary to our study, basing on the results of their study carried out with 12 patients, Miyanishi et al. reported that there was no significant relation between the extent of the bone marrow edema and the length of the subchondral hypointense line.[5] This difference, in our opinion, is due to the fact that Miyanishi et al. evaluated only the length of the subchondral fracture in their study. We also think that the level of conforming to therapy and exposure of the patients to additional trauma during the symptomatic treatment of TOH may be effective in the development of the subchondral fracture. The imaging modality of choice in the transient osteoporosis of the hip should be MRI.[14] Clinical findings recover spontaneously within 4 to 9 months with symptomatic treatment (bed rest and decreased loading). However, it is quite important to precisely diagnose the condition and following diagnosis, to be able to interpret the estimated recovery period with regard to physician-patient relationship and planning of patient's future life. Thus, the knowledge of determinant MRI findings related to the duration of the recovery period is important both for the patient and the physician. The basic limitation of our study was the small number of patients due to the fact that TOH is a rather rare condition. Thus, statistical evaluation of patient's data couldn't be carried out. However, despite the limited number of patients, the present study is quite valuable in pointing out the involvement variability of the proximal femoral region on an individual patient's basis and in exploring the possible close relation between recovery periods of clinical findings and presence and size of a subchondral fracture and extent of the bone marrow edema as observed in the patients' MRIs.

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