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ORIGINAL STUDY

Factors influencing outcome of knee bone marrow oedema : A clinical study

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Bone marrow oedema has a long recovery time. Conservative and surgical treatments have been used. This study aimed at identifying a profile of patients who may benefit from nonsurgical management. We compared the results of periodic clinical and radiological examinations of patients who visited our clinic with knee pain and were diagnosed with bone marrow oedema following magnetic resonance imaging (MRI) examinations. Clinically, the patients were evaluated using the Lysholm knee score and a visual analogue scale.

The study included 67 patients (31 males, 36 females) who were followed for 6-24 months. Patient age, gender, body mass index, affected area, and concomitant intra-articular pathology were analysed. Of the 67 patients, 63 were treated conservatively, and four underwent decompression.

Patients with involvement of both the medial femoral condyle and tibial plateau were found to be more resistant to treatment than those in which only the tibial plateau was affected. Intra-articular pathologies were frequently noted together with bone marrow oedema, causing knee pain to persist after the bone marrow oedema had subsided.

Keywords : bone oedema ; conservative management.

INTRODUCTION

In the early stage, bone marrow oedema (BMO) cannot be imaged directly using radiography or computed tomography and is identified only by magnetic resonance imaging (MRI) (*8,13,17*). In this syndrome, the affected joint is painful at rest, and the pain increases with load bearing. Owing to the long recovery time, it causes morbidity and time off work. Usually, the condition heals in a self-limited manner over weeks or months (*9*). As BMO may be associated with many conditions, ranging from traumatic bone contusion to neoplastic lesions, it is important to establish the diagnosis quickly and meticulously (*5,11*).

In the literature, patients with classical bone marrow oedema are described as 30-60 years old

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with a single painful bone in a joint (*7*). To treat the disease, conservative methods, medical treatment, and decompression methods, including drilling, have all been recommended (*3,4*).

In this study of patients diagnosed with BMO in the knee, we performed clinical and radiological (MRI) evaluations of BMO according to patient age, gender, body mass index (BMI), affected area, and accompanying intra-joint pathologies. We constructed a profile of patients who may benefit from non-surgical treatment.

PATIENTS AND METHODS

This study evaluated 97 patients (47 males, 50 females) who were examined for knee pain at our clinic within a 2-year period and who were identified as having BMO on knee MRI. Of these patients, eight males and 10 females did not return for the second or third evaluations and were excluded from the study. In addition, three males and four females who were revealed via MRI to have osteoarthritis with subchondral bone marrow oedema, two males with a history of acute trauma (stress fractures), and three males with osteochondral defects were excluded from the study. The 67 patients included in the study were monitored at 2-month intervals using MRI and were followed clinically for 6-24 months.

In the baseline evaluation, the medical histories of the patients were obtained and patient age, height, weight, and MRI results were recorded. BMI was calculated. The clinical evaluation included using the Lysholm knee score and a visual analogue scale (VAS) (*2,16*). The bone marrow was quantified based on MRI results, using a 1-mm transparent measurement template (*6*).

Patients diagnosed with bone marrow oedema on MRI were recommended to use crutches or canes to avoid overloading the affected side for 2 months. Conservative treatment consisting of intermittent local ice treatment and non-steroidal anti-inflammatory drugs was initiated.

The location of the BMO as determined on the first MRI was recorded : medial or lateral femur condyle, medial or lateral tibia plateau. Any change in the BMO or affected bone region was evaluated by a subsequent MRI examination. Concomitant intra-articular pathologies and their changes observed on the subsequent MRI were recorded. After 2 months, another clinical and MRI evaluation was performed. The conservative treatment was continued in patients with at least a 50% decrease in BMO on the follow-up MRI, and another clinical and radiological evaluation was performed at 4 months. The Lysholm knee score and VAS evaluations were performed at the 4-month follow-up in cases with no oedema evident at the 2-month MRI examination. When no oedema was observed at the 4-month MRI examination, only the Lysholm knee score and VAS evaluations were performed at the 6-month follow-up. When full radiological and clinical recovery was observed at any stage during the follow-up, the patients were allowed to apply load on the affected side, and their follow-up was terminated. When full recovery from BMO was observed at successive MRI examinations, but a minimum increase of 15 points in the Lysholm knee score and a minimum decrease of 30 points in the VAS evaluation were not seen, the clinical evaluations were continued at 6-month intervals.

Decompression by drilling was performed in three males and one female (on the 2nd month examination 1 patient, on the 4th month examination 2 patients and on the 6th month examination 1 patient) when the clinical results indicated no recovery with conservative treatment and a decrease of 50% in BMO was not seen on MRI. One male was diagnosed with medial meniscal rupture and anterior cruciate ligament rupture ; the bone marrow had recovered clinically and radiologically at the 6-month evaluation, but arthroscopy and anterior cruciate ligament reconstruction were done. In this patient, the Lysholm score was 79, the VAS score was 20, and no BMO was observed on MRI at the 14-month follow-up.

We also evaluated the correlations among the distributions and averages of gender, height, weight and BMI, baseline and final Lysholm knee scores, baseline and final VAS scores, localisation of BMO on MRI, course of BMO, and concomitant intra-articular pathologies. Statistical analyses were performed using NCSS 2007. In addition to descriptive statistics (mean ± standard deviation), pairs of groups were compared with the independent *t*-test, multiple groups were compared by one-way analysis of variance (ANOVA), and subgroups were compared using Tukey's multiple comparison test. The significance level was set at $p < 0.05$.

RESULTS

The average patient age was 54.4 years. There were 36 females and 31 males. The mean BMI was 29.25. Ten patients were thin, 30 were normal, and 27 were slightly overweight or obese (Table I). The follow-up ranged from 6 to 24 months (mean, 13 months ; median, 12 months). The mean difference

Table I. — Demographic characteristics and clinical findings in the patients

Parameter	Mean ± SD	Minimum	Maximum
Age (years)	54.37 ± 12.62	25	83
Follow-up time (months)	13.12 ± 4.85	6	24
Height (m)	1.65 ± 0.09	1.50	1.82
Weight (kg)	78.54 ± 11.12	50	105
BMI	29.25 ± 4.76	20.7	44.8
Lysholm score-baseline	55.91 ± 12.9	18	80
Lysholm score-final	89.09 ± 8.08	65	100
VAS-baseline	63.51 ± 22	20	100
VAS-final	17.22 ± 15.6	0	60
Lysholm-difference	33.18 ± 12.36	11	63
VAS-difference	46.28 ± 22.33	–20	100

Table II. — Areas of bone affected by BMO

Affected Bone Area	Number of patients	Percentage
Medial femoral condyle	30	44.77
Medial femoral condyle + medial tibial plateau	17	25.37
Medial tibial plateau	11	16.41
Lateral femoral condyle	4	5.97
Lateral tibial plateau	3	4.47
Lateral femoral condyle + lateral tibial plateau	1	1.49
Patellofemoral joint	1	1.49

between the baseline and final Lysholm scores was 33.2 ± 12.4, and the mean difference between the baseline and final VAS scores was 46.3 ± 22.3.

The medial compartment of the knee was the area most frequently affected by BMO. The medial femoral condyle was involved in 44.77% of the cases, and the medial femoral condyle plus the medial tibial plateau were involved in 25.37% (Table II).

The concomitant intra-articular pathologies seen on MRI were cartilage lesions only (35.8% of the cases), cartilage lesions with medial meniscal rupture (17.9%), medial meniscal rupture only (16.41%), lateral meniscal rupture only (4.5%), and combined medial and lateral meniscal rupture (2.9%) (Table III).

The mean post-treatment Lysholm and VAS scores differed significantly from the pre-treatment scores (both $p = 0.0001$). The post-treatment mean Lysholm scores differed significantly among the affected area groups ($p = 0.03$), although the mean improvement in the Lysholm score did not differ significantly according to the affected area ($p = 0.435$). The group in which both the femur and tibia were affected had a significantly lower mean improvement in the Lysholm score compared with the group in which only the tibia was affected ($p = 0.036$) ; no significant difference was observed between the other groups ($p > 0.05$). There was no significant difference in the mean improvement in the Lysholm score between the groups with and without concomitant intra-articular pathology ($p = 0.672$).

No correlation was found between the area of bone marrow oedema and patient age, weight, or BMI (Table IV), and no significant correlation was found between the area of bone marrow oedema and

Table III. — Distribution of concomitant intra-articular pathologies

Intra-articular pathology	Number of patients	Percentage
CP + MMD ± LMD	16	23.88
MMT + CP	12	17.91
MMT	11.	16.41
CP	8	11.94
MMD + LMD	5	7.46
LMT	3	4.47
MMT + LMT + CP	2	2.98
ACLT + MMT + LMT	1	1.49
ACLT	1	1.49
No intra-articular pathology	8	11.94
Total	67	100

CP, chondropathy ; MMD, medial meniscus degeneration ; MMT, medial meniscus rupture ; LMD, lateral meniscus degeneration ; LMT, lateral meniscus rupture ; ACLT, anterior cruciate ligament rupture.

Table IV. — Correlation of BMO location with age, weight, and BMI

Factor	Femur	Tibia	Femur + Tibia	F	p
Age	55.4 ± 11.91	51.07 ± 14.71	55.18 ± 12.37	0.66	0.521
Weight (kg)	78.86 ± 10.53	81.4 ± 9.58	75.35 ± 13.27	1.22	0.303
BMI	29.31 ± 4.15	29.67 ± 5.76	28.75 ± 5.22	0.15	0.861

the existence of intra-articular pathology ($p = 0.373$). The group with concomitant intra-articular pathology was significantly older ($p = 0.002$) and had a higher BMI ($p = 0.003$) compared with the group without intra-articular pathology.

DISCUSSION

This study compared the results of periodic clinical and radiological evaluations of patients who visited our clinic with knee pain and were diagnosed with bone marrow oedema following MRI examinations. The results suggest a profile of patients who may benefit from conservative treatment.

There were some limitations to our study. The recovery time may vary depending on aetiological factors in some cases. Therefore, a mean follow-up of 13 months may not have been sufficient in some cases. All of the bone marrow oedema patients received treatment, and were not compared with a similar untreated group.

The literature describes bone marrow oedema as a self-limited disease. However, the diagnosis is difficult because it cannot be visualised directly with plain radiography, and its long course of recovery, when left untreated, leads to morbidity and causes loss from the labour force. BMO persisted in 69% of the cases after 4 weeks and in 12% after 12 weeks.

Bennell *et al* measured the adduction moment of the knee while walking and performed MRI in 91 knee osteoarthritis patients (*2*). BMO location was evaluated along with patient age, gender, and BMI. The medial tibial plateau was involved in 64% and the medial femoral condyle in 60% of the patients. They showed that the peak adduction torque was higher at the medial tibial plateau than at the femoral condyle. This result supports the hypothesis that BMO occurs via mechanical loading during the pathogenesis of tibiofemoral osteoarthritis (*2*). We also observed that BMO most frequently affected the medial femoral condyle, alone or together with

the medial tibia plateau. Concomitant femur and tibia involvement reduces the chance for successful conservative treatment, but the success rate is increased when only the tibia is affected.

In a study of the prevalence of intra-articular problems in patients with BMO in the knee, Stehling *et al* investigated the physical activity level as a risk factor compared with age, BMI, and knee osteoarthritis development (*13*). They reported cartilage damage in 74.6% of the patients, meniscal lesions in 47%, BMO in 40.3%, and ligament lesions in 17%. They concluded that in asymptomatic, middle-aged individuals, a high physical activity level is a major risk factor for the development of meniscus and ligament pathology independent of age, BMI, and osteoarthritis risk factors (*13*). Vincken *et al* reported that 18.7% of the patients with subacute knee complications assessed with MRI had BMO, and this rate was significantly higher than the rates for complete ACL, lateral meniscal, medial collateral ligament (MCL), and lateral collateral ligament (LCL) ruptures (*16*). The correlation between BMO and MCL rupture was significant in subacute knee pathologies. BMO was observed to decrease at the 6-month follow-up. We also studied the correlations between intra-articular problems and BMO and observed a high rate of concomitant BMO and intra-articular pathologies, most frequently osteochondral lesions (not osteochondral defects) and medial meniscus rupture. However, we did not observe any difference in the improvement in the Lysholm score between groups with and without intra-articular pathology. In addition, we did not detect any correlation between the existence of intra-articular pathology and the area of BMO.

In a series of 51 patients evaluated for a period of 1 year at 3-month intervals, Unay *et al* demonstrated a correlation between the decrease in BMO and decrease in pain during activity and showed that the decrease in pain at rest was not correlated with a decrease in BMO (*15*). In our study, pain during activity and during rest were not investigated separately ; the VAS and Lysholm scores used in a general investigation of pain indicated a decrease in pain.

Age, BMI, and intra-articular pathologies may play a role in BMO development, and they may also cause BMO to persist longer, to be more resistant to treatment, and to recover with sequelae in these patient groups. This suggests that post-BMO recovery pain is associated with other complications of the knee, particularly with increased cartilage damage in patients with chondropathy.

Decompression quickly reduces the pain of BMO. In a comparison of patient groups treated with conservative approaches and with decompression, Radke *et al* reported that while the clinical outcomes were similar in both groups, the patients treated with surgery recovered more rapidly (*10*). In a study of 24 knees in 18 patients treated with decompression, full recovery was reported in all patients at the end of 5 years (*3*). In our study, four patients who underwent decompression had fewer complaints of pain at the 2-month follow-up, and the BMO had disappeared on MRI.

Overall, the conservative treatment of idiopathic bone marrow oedema had a high success rate in this study. The presence of concomitant intra-articular pathology did not affect the final rate of clinical recovery but recovery took longer when bone marrow oedema was accompanied by intra-articular pathology, especially when both the medial femoral condyle and medial tibial plateau were affected. In these patients, alternatives to conservative treatment may be necessary.

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