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의학석사 학위논문

The Natural Course of Subchondral Fatigue Fracture of the Femoral Head

대퇴골두 연골하 피로 골절의 자연 경과

2020년 8월

서울대학교 대학원

의학과 정형외과학

이 선 형

Abstract

Introduction: Subchondral fatigue fracture of the femoral head (SFFFH) is a rare disease, and its disease entity is established in recent decades. Although there are a few studies about SFFFH, most of them are case series within 10 cases, and the natural course of SFFFH is not well known. In this study, the natural course of SFFFH and clinical and radiological factors affecting it will be analyzed.

Materials and Methods: The patients who had visited the hip clinic of the orthopaedic department in our institution from October 2000 to January 2019 were retrospectively evaluated. Of all the eligible cases, 89 hips in 80 patients were diagnosed with SFFFH and analyzed. They were 51 males and 29 females with a mean age of 35.4 years (range, 18-60). The mean follow-up period was 15.5 months (range, 0.3-191). Conservative treatment was done through reduced weight-bearing and pain medication. Surgery was performed in the following two conditions: 1) there was no improvement of hip pain with conservative treatment, and arthritic changes progressed on serial radiographs. 2) at the first visit, the collapse of the femoral head was so severe ($> 4\text{mm}$) that the hip pain was not expected to improve with

conservative treatment. Radiographs of anteroposterior and frog-leg views were taken at each visit. Radiographs were reviewed for the presence of collapsed head, osteoarthritic changes, and dysplastic features of the hip joint. The location of the subchondral fracture and the extent of bone marrow edema were analyzed through a magnetic resonance image (MRI). The medical charts were reviewed to find out the interval between the onset of hip pain and the first visit, and the period that the hip pain had improved.

Results: The subchondral fracture was all located on the superior portion of the femoral head, except for one case; the posteroinferior portion of the femoral head. There were 48 cases (53.9%) of bone marrow edema within half of the femoral head, 19 cases (21.3%) of bone marrow edema observed in more than half of the femoral head but not exceeding the head, and 22 cases (24.7%) of bone marrow edema beyond the femoral head. Of all cases, 82 cases (92.1%) improved their hip pain through conservative treatment, and seven cases (7.9%) underwent surgery. Patients with good results for conservative treatment improved on average 2.9 months (range, 0.3-12). The 71 cases had visited our institution within six months from the onset of hip pain. Of these, all the cases with 0 to 4mm of femoral head collapse (68 cases)

improved their pain on the hip joint through conservative treatment. Cases with collapsed femoral head over 4mm (three cases) all underwent surgery. The other 18 cases had visited our hospital for more than six months from the onset of hip pain. Of these, all the cases without femoral head collapse (nine cases) improved their pain on the hip joint with conservative treatment. Of the rest (nine cases) with collapsed femoral head, four cases had undergone surgery eventually. The OA changes at the time of the first visit, the presence of dysplastic hip, sex, and age were not related to the success of conservative treatment for SFFFH.

Conclusions: Conservative treatment is useful for SFFFH patients who visited the hospital within six months from the onset of hip pain, except the collapse is exceeding 4mm. Conservative treatment is not likely to be effective if SFFFH patients with hip pain who visited the hospital for more than six months from the onset of the pain had a collapsed femoral head.

Keywords: Hip, Subchondral fracture, Natural course, Prognosis, Fatigue fracture

Student number: 2015-21994

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Introduction

Subchondral stress fracture of the femoral head (SSFFH) is a rare disease, and its disease entity is established in recent decades. SSFFH consists of subchondral insufficiency fracture of the femoral head (SIFFH) and subchondral fatigue fracture of the femoral head (SFFFH). SIFFH occurs in patients whose bone quality is abnormal due to osteoporosis or other causes, and SFFFH occurs in healthy adults with normal bone quality.

Although there are a few studies about clinical outcomes of SFFFH, most of them are case series within 10 cases¹⁻⁴, and the natural course of SFFFH is not well known. SFFFH without collapse seems to be recovered well based on the previous studies¹⁻³. For SFFFH with collapse, however, some reported that it recovered well without surgical treatment³, while others reported that it required surgical treatment eventually⁵.

In this study, the natural course of SFFFH and the factors affecting it will be analyzed. Through this study, we intended to investigate whether the following factors are related to the success of conservative treatment of SFFFH: (1) the degree of the collapsed femoral head; (2) the interval between the onset of hip pain and the visit to a hospital; (3) osteoarthritic changes of the hip joint; and (4) the presence of dysplastic hip.

Materials and Methods

Study population

The patients who had visited the hip clinic of the orthopaedic department in our institution from October 2000 to January 2019 were retrospectively evaluated. The patients who meet the following conditions were diagnosed with SFFFH^{4, 6}: (1) normal bone quality; (2) radiographs that are normal or show the collapse of the femoral head; (3) a subchondral low signal intensity band on T1-weighted magnetic resonance images (MRI); (4) a bone marrow edema pattern surrounding the aforementioned subchondral band in the femoral head; and (5) an absence of additional abnormal signal intensity band outside the subchondral fracture line. The patients who satisfy the following criteria were considered to have normal bone quality: (1) age 60 years or under; (2) without underlying disease affecting the normal bone quality such as secondary osteoporosis, osteogenesis imperfecta, and et cetera; and (3) the Singh index⁷ of the hip was five or six. There were 104 patients diagnosed with SFFFH. Among them, patients with one of the following conditions were excluded: (1) having undergone surgery for SFFFH before visiting our institution; or (2) follow-up loss before the disappearance of the hip pain or being undergone an operation. Among 104 patients, nine patients had undergone surgery for affected hip before visiting our institution and 15 patients had lost to follow-up before relieving hip pain or surgery. Finally, 89 hips in 80 patients were evaluated (Figure 1). They were 51 males and 29 females with a mean age of 35.4 years (range, 18-60). The mean follow-up period was 15.5 months (range, 0.3-191) (Table 1).

Treatment for the patients

Initially, conservative treatment was done through reduced weight-bearing with crutch gait and pain medication. Close follow-up was done with the interval not exceeding one month. After that, the interval is adjusted according to the severity of the patients' pain on the hip joint, and patients gradually returned to their daily lives. Conservative treatment was considered successful if the patient returned to normal daily life without hip pain. Surgery was performed in the following two conditions: (1) there was no improvement of hip pain with conservative treatment, and arthritic changes progressed on serial radiographs; or (2) at the first visit, the collapse of the femoral head was so severe ($> 4\text{mm}$) that the hip pain was not expected to improve with conservative treatment. Collapse exceeding 4mm was considered severe according to the ARCO system⁸. The type of surgery was determined by the existence of arthritis. Total hip arthroplasty was performed if there were arthritic changes on a hip joint, and reduction with bone graft was performed if there were not.

Radiologic evaluation

Radiographs of anteroposterior and frog-leg views were taken at each visit. Radiographs were reviewed for the presence of collapsed head, osteoarthritic changes, and dysplastic hip. If there was a collapse, maximum depression of the collapsed femoral heads was measured using concentric circles⁸. Cases were then grouped by the degree of collapse with modification of ARCO system⁸: without collapse, collapse with 0 to 4mm, and collapse exceeding 4mm. Osteoarthritic

changes included definite osteophyte, joint space narrowing, and subchondral cyst. Lateral center-edge angle (LCEA) was measured following the Wiberg's method⁹. Hips with an LCEA $<20^{\circ}$ defined as dysplastic hip, hips with an LCEA $>25^{\circ}$ defined as normal, and hips with an LCEA between 20° and 25° were defined as borderline dysplastic hip⁹.

MRI was obtained at an average of 3.1 months (range, 0.5 – 39) after the onset of hip pain. The location of the subchondral fracture and the extent of bone marrow edema were analyzed through MRI.

Clinical evaluation

The medical charts were reviewed to find out the period between the onset of hip pain and the first visit, and the period that the hip pain had improved.

Statistical analysis

Univariate logistic regression analysis was used respectively to examine possible correlations of sex, age, arthritic changes, or dysplastic hip with the prognosis of SFFFH. Dysplastic hip was grouped into two categories by LCEA: dysplasia ($<20^{\circ}$), and borderline dysplasia (20° - 25°). Otherwise considered as normal hip ($>25^{\circ}$). A p-value of < 0.05 was considered significant. Statistical analysis was performed using SPSS for Windows, version 25.0 (SPSS Inc., Chicago, IL, USA).

Results

Overall results

The subchondral fracture was all located on the superior portion of the femoral head, except for one case; the posteroinferior portion of the femoral head. Among the 88 cases (98.9%) of fractures located on the superior part, 48 cases (53.9%) were located on the anterosuperior area, 19 cases (21.3%) were located on the mid-superior area, and 12 cases (13.5%) were located on the posterosuperior area. There were 8 cases (9.0%) of subchondral fracture located from anterosuperior to mid-superior portion. There was also a case (1.1%) of subchondral fracture across the entire superior part of the femoral head.

There were 48 cases (53.9%) of bone marrow edema within half of the femoral head, 19 cases (21.3%) of bone marrow edema observed in more than half of the femoral head but not exceeding the head, and 22 cases (24.7%) of bone marrow edema beyond the femoral head.

Of all cases, 82 cases (92.1%) improved their hip pain with conservative treatment, and seven cases (7.9%) underwent surgery. Patients with good results for conservative treatment improved their pain on the hip joint on average 2.9 months (range, 0.3-12) (Figure 2). Of the cases undergone surgery, five underwent surgery immediately due to their largely collapsed ($> 4\text{mm}$) femoral heads (Figure 3A-C), and two underwent surgery after conservative treatment for 12 and 18 months, respectively (Figure 3D-F). Reduction and bone graft were done in four cases, and total hip arthroplasty was done in three cases. One of the patients who had a reduction

and bone graft showed progression of arthritic changes on serial radiographs and had persistent pain. Total hip arthroplasty was performed for the patient eventually in the postoperative three years.

The followings are the information on two cases that failed to conservative treatment and underwent a surgical procedure. The first case was a 37-year-old male patient who started to feel discomfort on his right hip after running vigorously to lose his weight. After 12 months of discomfort, he visited the outpatient clinic of our institution and was diagnosed with SFFFH. Radiographs of the first visit showed the slightly flattened femoral head with minimal joint space narrowing. Although conservative treatment was continued, the patient felt persistent hip pain and osteoarthritic changes of the affected hip worsened. After 12 months of conservative treatment, total hip arthroplasty was performed eventually. The second case was a 60-year-old female patient who complained of pain on her right hip after the event of missing her step. After 43 months of discomfort, she visited our institution and was diagnosed with SFFFH. The slightly flattened femoral head with joint space narrowing and osteophytes were shown on radiographs of the first visit. Conservative treatment was maintained for 18 months. However, the femoral head became more collapsed and osteoarthritic change progressed. Furthermore, hip pain did not improve, so total hip arthroplasty was performed.

Collapsed femoral heads

Of 89 cases, 55 cases did not show a collapse in their femoral head. They all improved their pain on the hip after conservative treatment. The other 34 cases had

collapsed femoral head from the first visit. Of them, 30 cases had a collapse of 4mm or less, and four cases had a collapse exceeding 4mm. Of the 30 cases with a collapse of 4mm or less, 27 improved the hip pain after conservative treatment, and three underwent surgery: two cases with total hip arthroplasty after conservative treatment for 12 and 18 months, respectively (Figure 3D-F), and one case with immediate reduction and bone graft (Figure 3A-C). All four cases with collapse exceeding 4mm underwent an operation after the first visit (Figure 4).

The interval between the onset of hip pain and the first visit

Of 89 cases, 71 cases visited our institution within six months from the onset of hip pain, and 18 cases visited after six months. Of the 71 cases that visited our institution within six months, 46 cases had no collapsed femoral head at the first visit, 22 cases had a collapse of 4mm or less, and three cases had a collapse exceeding 4mm. All the cases except three that had collapse exceeding 4mm improved their pain on the hip through conservative treatment.

Of the 18 cases that visited our institution after six months from the onset of hip pain, nine cases had no collapsed femoral head at the first visit, eight cases had a collapse of 4mm or less, and one case had a collapse exceeding 4mm. All nine cases without collapse improved their pain on the hip through conservative treatment.

Of the eight cases with collapse within 4mm, three underwent surgery and one patient was recommended surgery for persistent pain but refused to do so. Immediate surgery was done for one case of collapse exceeding 4mm (Figure 4).

Osteoarthritic changes

The OA changes at the first visit were shown in 11 cases. Of these, surgery was performed in two cases. OA changes at the first visit did not show statistical significance with the success of the conservative treatment. ($p = 0.20$).

Dysplastic hip

Based on LCEA, 74 cases had normal hip morphology, 12 cases had borderline dysplastic hip, and three cases had dysplastic hip. Surgery was performed in four cases of normal hips, two cases of borderline dysplastic hips, and one case of dysplastic hips. Whether hip was dysplastic or not did not associate with the success of the conservative treatment in univariate analysis (borderline dysplastic hip, $p = 0.10$; dysplastic hip, $p = 0.53$).

Sex and age

Sex and age did not associate with the success of the conservative treatment in univariate analysis ($p = 0.19$ and 0.15 , respectively) (Table 2).

Discussion

In this study, most of the patients (92.1%) with SFFFH improved their hip pain through conservative treatment in about three months. Three months is a general fracture healing period, and it can be reasoned that subchondral “fracture” was healed through reduced weight-bearing and conservative treatment. However, conservative treatment was not effective in all cases, and the surgical procedure was inevitable in some cases. Based on the results of this study, the success of conservative treatment for SFFFH could be predicted from the severity of the collapsed femoral head and the interval between the onset of hip pain and the first visit to the hospital. We carefully introduce the algorithm of SFFFH’s treatment decision (Figure 5).

The period from onset of hip pain to hospital visits can also be considered as the period from onset of hip pain to the start of conservative treatment. If conservative treatment began within six months of the hip pain, conservative treatment was effective except in the cases with collapsed femoral head exceeding 4mm (68 of 68 cases, 100%) (Figure 4). If conservative treatment began more than six months after the hip pain, conservative treatment was effective only in the cases without collapse (9 of 9 cases, 100%) (Figure 4). Delayed conservative treatment was less effective in the cases with the collapsed femoral head; surgery was performed in four of nine cases with collapse, and in one case, there was persistent pain, but surgery was not performed because of the patient’s rejection. Besides, the remaining five cases had already recovered from pain at the time of their first visit. In other words, delayed conservative treatment for more than six months was effective if the patient had no

collapse, but was not effective in patients with hip pain and the collapsed femoral head.

Previous papers also showed results consistent with this study. Song et al.¹ reported that of five cases with SFFFH, three cases without collapse recovered well, and two cases with marked collapse underwent surgical management. According to Kim et al.², five cases with SFFFH, four without collapse, and one with collapse less than 4mm, all improved their symptoms with conservative management. All five patients had visited the hospital within one week to three months from the onset of the hip pain. Yamamoto et al.⁶ reported 14 male SFFFH cases and informed 12 cases recovered well, and two cases had surgical treatment. But, the extent of collapse and the time from onset of the hip pain to the hospital visit were not described.

Lee et al.³ reported that all the nine collapsed SFFFH cases improved with conservative treatment and surgical treatment was not necessary. However, three of the nine cases had received surgical treatment before visiting the institution. And only one case had collapsed femoral head exceeding 4mm. It was not specified in the article that which case had undergone surgery before the first visit, but it can be presumed that the case with collapse more than 4mm was the case that had undergone surgery before the visit. Except for this one, all the cases had collapse less than 4mm. This explains why all the cases in this study showed good results with conservative treatment despite of the collapsed femoral head.

Kim et al.⁵ reported the fate of SFFFH with 34 cases. They suggested novel staging of SFFFH. In stage IIb and more, with collapsed femoral head and depressed articular margin, surgical treatment was required eventually. In stage IIa and below, with a collapsed femoral head but without depressed articular margin, conservative

treatment was sufficient. The need for surgical treatment in all collapsed cases with depressed articular margin seems to be a conflict with Lee's results³. However, the extent of collapse with a depressed articular margin was likely more than 4mm. In addition, the period from the onset of hip pain to the first visit in the study was relatively long with an average of 4.4 months (range, 0.5-16). These may have influenced the author's conclusion that collapsed femoral heads require surgical treatment eventually.

Iwasaki⁴ and Ikemura¹⁰ also reported five and 15 cases of SSFFH, respectively. But it was difficult to say that included cases were true SFFH because the bone quality was abnormal⁴ or the age of patients group ranged 36 to 83 years old¹⁰.

Patients with OA changes from the first visit may have a higher risk of failure of conservative treatment because arthritis is an irreversible progressive change. The relationship between the success of the conservative treatment with OA changes like osteophytes or joint space narrowing was evaluated in this study. However, of the 11 cases with OA changes, only 2 cases (18.2%) failed with conservative treatment. Besides, OA changes did not show statistical significance with recovery with conservative treatment.

Previous biomechanical studies showed the joint contact pressure of dysplastic hips is concentrated on the lateral edge of the acetabulum¹¹⁻¹³. This can worsen the collapse and decrease the therapeutic effect of conservative treatment¹³. But, in univariate analysis, hip dysplasia did not affect the success of the conservative treatment with statistical significance in this study.

In this study, 89 cases were analyzed, and it can be insufficient to describe a true natural course. But 89 cases were far larger numbers than those of the previous papers,

and considering the rareness of the disease entity, the number of cases is thought to be sufficiently large to evaluate the factors affecting the success of the conservative treatment. In cases with the markedly collapsed femoral head ($> 4\text{mm}$), authors did surgical treatment immediately. It cannot be denied that there was a possibility of getting good results through conservative treatment for these cases also. However, for reducible fractures that are less than three months after the occurrence, the authors judged that maintaining conservative treatment only was not ethically right. Another limitation is the lack of body mass index (BMI) information in this study. Most of the BMI data of the included cases were not available because BMI data of outpatients were not routinely measured in our institution. The relation between OA changes and the success of the conservative treatment may not have been revealed in this study due to the short follow-up period. Arthritis is a disease that progresses slowly over a long period, so it is necessary to observe the results of conservative treatment through long term follow-up. In addition, further research will also be needed on whether more arthritic changes occur in SFFFH patients in long term follow-up than the normal population.

In conclusion, the success of conservative treatment of SFFFH is affected by the degree of the collapsed femoral head and the time of beginning conservative treatment. Conservative treatment is useful for SFFFH patients who visited the hospital within six months from the onset of hip pain, except the collapse is exceeding 4mm. Conservative treatment is not likely to be effective if SFFFH patients with hip pain who visited the hospital for more than six months from the onset of the pain had a collapsed femoral head.

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Table 1. Patient characteristics

Variables	
Patients (hips)	80 (89)
Gender	
Male	51
Female	29
Mean age (yrs) (range, SD)	35.4 (18-60, 12.5)
Mean follow-up (mos) (range, SD)	15.5 (0.3-191, 27.6)
The interval between the symptom onset and the first visit (mos) (range, SD)	5.2 (0.3-84, 10.7)
Maximum depression of the head (n)	
0mm	55
≤ 4mm	30
> 4mm	4
OA changes at the first visit (n)	
Absent	78
Present	11
Hip dysplasia (n)	
Normal	74
Borderline	12
Dysplastic hip	3

SD, standard deviation

Table 2. Statistical analysis of factors that can affect the success of conservative treatment

Factors	P-value*
Osteoarthritic changes	0.20
Dysplastic hip	
Borderline dysplastic hip	0.10
Dysplastic hip	0.53
Sex	0.19
Age	0.15

* By univariate logistic regression analysis

Figure 1. Study population

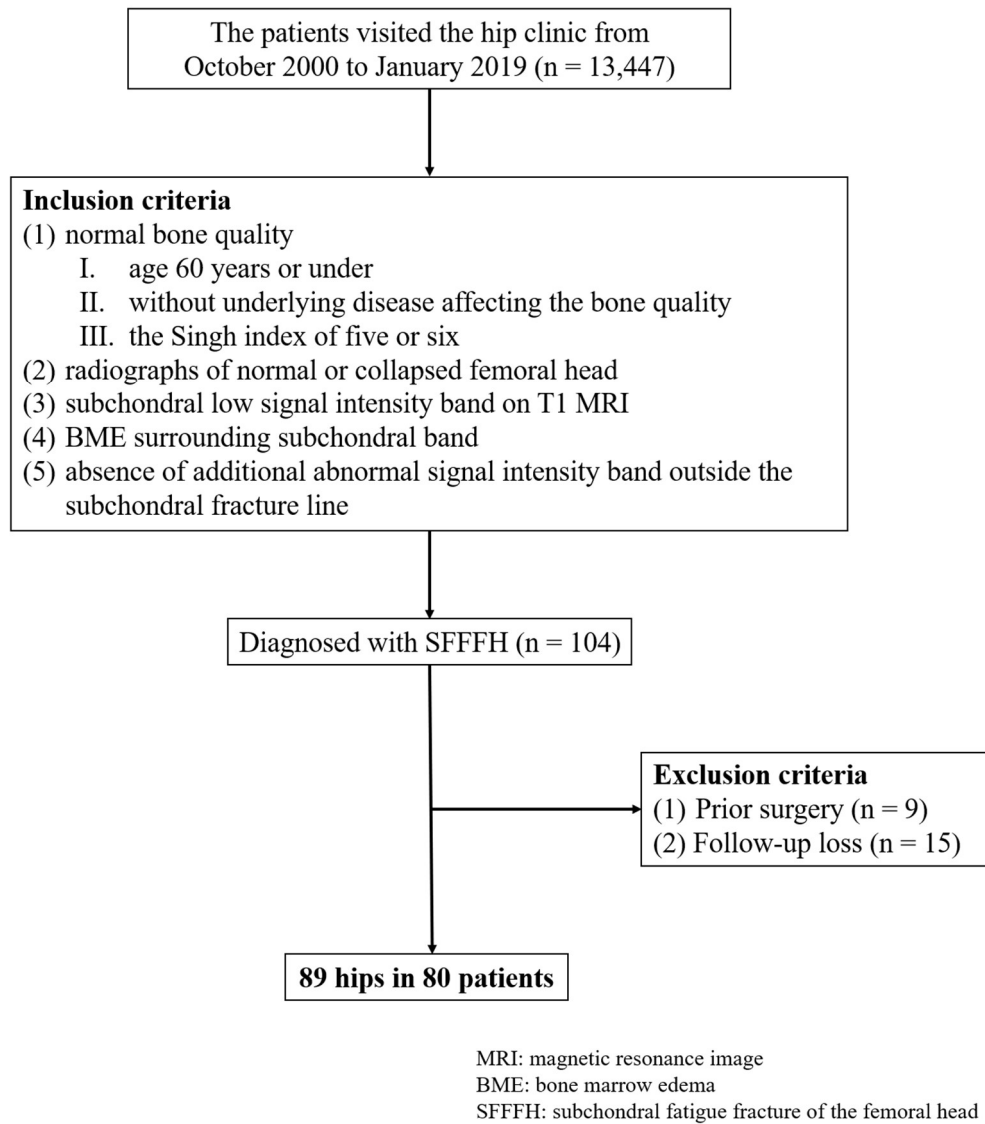
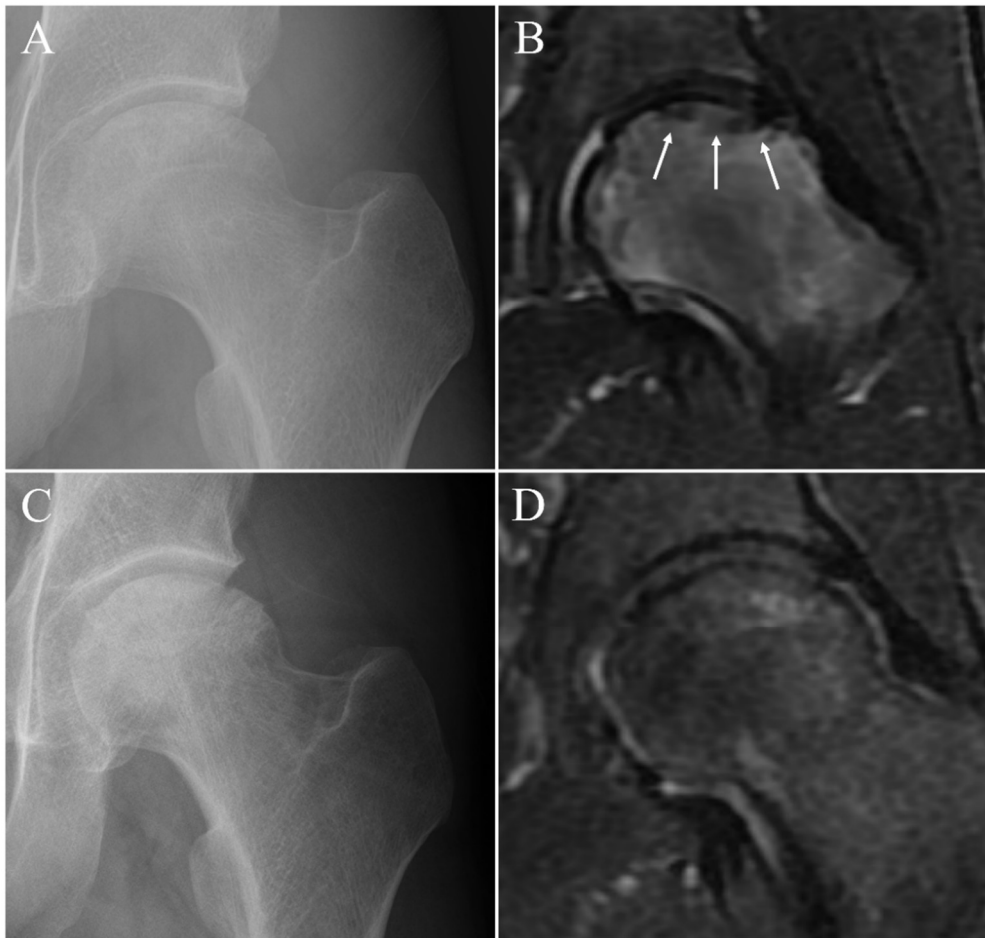
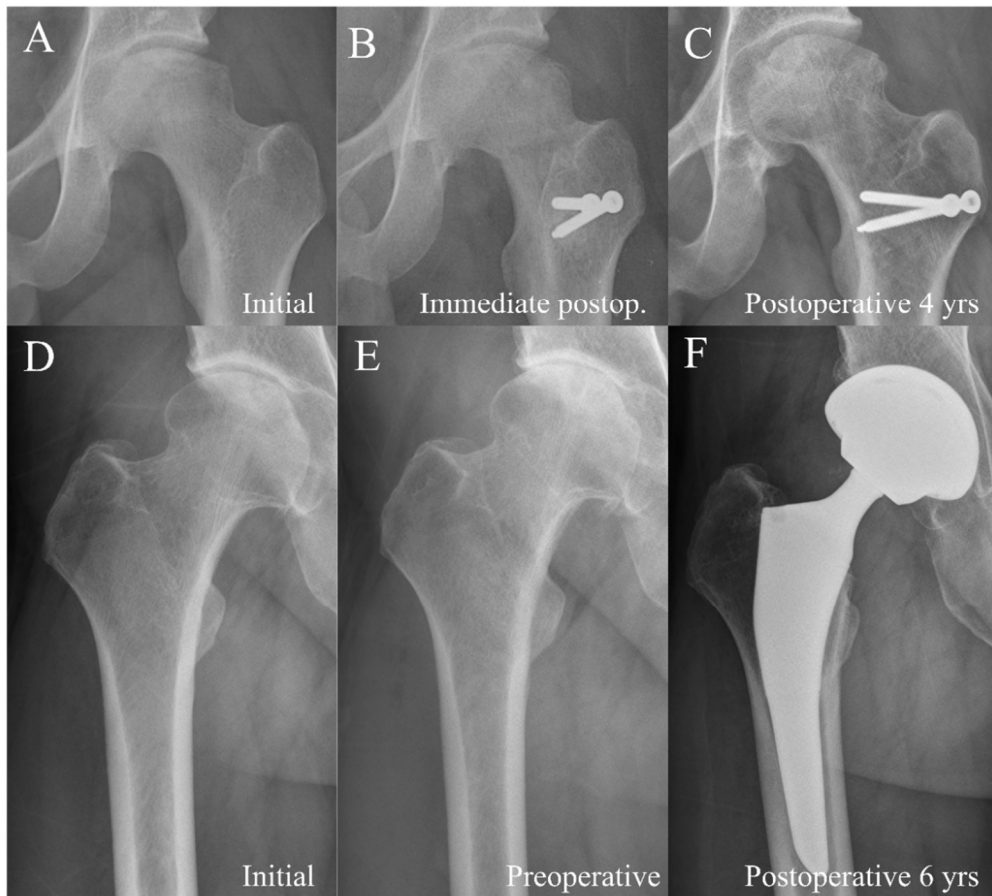


Figure 2. A case of successful conservative treatment



A 28-year-old male patient visited the hospital after one month from the onset of the pain in his left hip. (A) The initial radiograph showed a slightly flattened femoral head. (B) Fat-suppressed T2-weighted spin-echo MRI of the patient showed subchondral fracture (arrow) and bone marrow edema of the entire femoral head and neck. Through conservative treatment, the hip pain disappeared in 4 months. (C) The follow-up radiograph of 5 months after conservative treatment showed remained flattened femoral head with the sclerotic change. (D) The follow-up MRI after 15 months of the conservative treatment showed healed fracture line and decreased bone marrow edema of the femoral head.

Figure 3. Cases underwent surgical treatment



A 21-year-old male patient visited the hospital after one month from the onset of the pain in his left hip. (A) The initial radiograph showed a largely (5mm) collapsed femoral head. (B) Reduction and bone graft surgery was done immediately after the first visit. (C) The patient has been able to perform daily life without pain in the left hip for four years since the operation. (D) A 37-year-old male patient visited the hospital because of the pain in his right hip started 12 months ago. The initial radiographs showed a flattened femoral head. Conservative treatment through reduced weight-bearing was done for 12 months. (E) However, the hip pain had not decreased much, and the radiograph showed progressed osteoarthritic changes. (F) Finally, total hip arthroplasty was done.

Figure 4. The natural course of SFFFH in this study

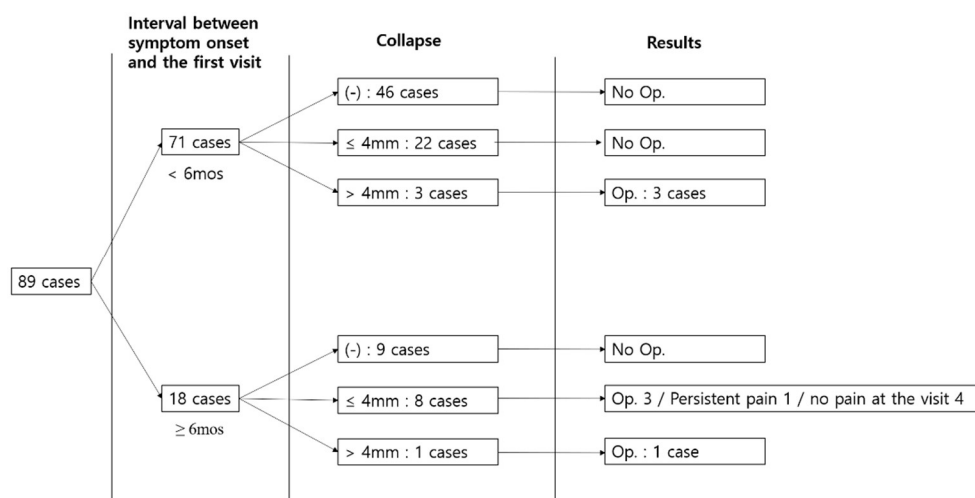
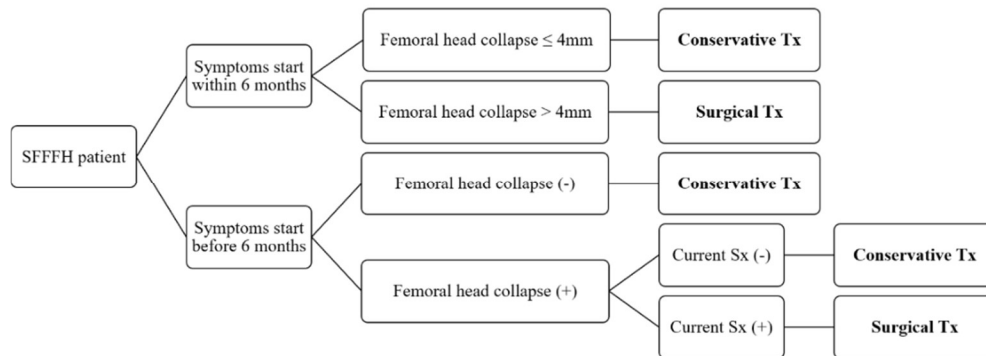


Figure 5. The algorithm of SFFFH's treatment decision



국 문 초 록

대퇴골두 연골하 피로 골절의 자연 경과

이선형

의학과 정형외과학

서울대학교 대학원

배경: 대퇴골두 연골하 피로 골절은 드문 질환으로서 질병에 대한 진단적 개념은 최근에 이루어졌다. 대퇴골두 연골하 피로 골절에 대한 몇 개의 보고들이 있지만 대부분 10례 이내의 증례 보고이고, 대퇴골두 연골하 피로 골절의 자연 경과는 잘 알려져 있지 않다. 이번 연구에서는 대퇴골두 연골하 피로 골절의 자연 경과와 이에 영향을 미치는 임상적, 영상학적 인자들을 분석해보고자 한다.

방법: 2000년 10월부터 2019년 1월까지 본 기관의 정형외과 고관절 외래에 방문한 환자들을 후향적으로 분석하였다. 최종적으로 80명의 환자들의 89례 고관절에서 대퇴골두 연골하 골절이 진단되었고, 이를 분석하였다. 대상자는 51명의 남자와 29명의 여자였으며, 평균 나이는 35.4세 (18-60세) 이고 평균 추시 기간은 15.5 개월 (0.3-191개월) 이었다. 부분체중부하 보행을 통한 보존적 치료를 시행하였고, 수술적 치료는 다음 두 가지 경우에 시행하였다. 1) 보존적 치료에 증상 호전이 없고 고관절염이 진행되는 경우, 2) 초진 당시 대퇴골두 함몰이 심하여 보존적 치료로 증상

호전을 기대하기 어려운 경우. 매 방문시마다 전후방 및 개구리다리 영상을 촬영하였고, 방사선 영상은 대퇴골두 함몰, 고관절염 변화, 비구 이형성증에 중점을 두어 분석하였다. 또한 연골하 골절의 위치와 골수 부종의 범위를 자기공명영상을 통하여 알아보았다. 그리고 증상 발현부터 초진까지의 기간 및 증상 호전에 걸린 시간을 의무기록 분석을 통하여 알아보았다.

결과: 대퇴골두 연골하 골절은 후하방에 생긴 한 레를 제외하고는 전부 대퇴골두 상방에서 발생하였다. 48례 (53.9%)에서 대퇴골두 절반 이하의 골수 부종이, 19례 (21.36%)에서 대퇴골두를 넘지 않는 골수 부종이, 그리고 22례 (24.7%)에서 대퇴골두를 넘어서는 골수 부종이 관찰되었다. 전체 89례 중에서 82례 (92.1%)는 증상 호전이 있었고 7례 (7.9%)는 수술적 치료를 겪었다. 보존적 치료에 호전을 보였던 환자들은 증상 호전까지 평균 2.9개월 (0.3-12개월)이 걸렸다. 71례는 증상 발현 후 6개월 내에 본원에 방문하였다. 이들 중 4mm 이하의 대퇴골두 함몰이 있는 경우 (68례)는 보존적 치료에 증상 호전이 있었다. 4mm가 넘는 대퇴골두 함몰이 있는 경우 (3례)는 수술적 치료를 받았다. 나머지 18례는 증상 발현 후 6개월이 넘어서 본원에 방문하였다. 이들 중 대퇴골두 함몰이 없는 모든 경우에서 (9례) 보존적 치료로 증상의 호전이 있었다. 골두 함몰이 있었던 나머지 (9례) 경우에는, 4례에서 결국 수술적 치료를 시행하였다. 초진 당시 고관절염 징후가 보이거나 비구 이형성증이 있었는지 여부, 성별, 그리고 나이는 대퇴골두 연골하 피로 골절의 예후와 연관이 없었다.

결론: 대퇴골두 연골하 피로 골절 환자들이 증상 발현 후 6개월 내에 병원을 방문한 경우에는 골두 함몰이 4mm를 넘지 않으면 모두 보존적 치료에 좋은 결과를 보였다. 증상 발현 후 6개월이 넘어 병원에 방문한 환자 중 증상이

지속되면서 골두 함몰이 있었던 환자들은 보존적 치료에 효과가 떨어졌다.

주요어: 고관절, 연골하 골절, 자연 경과, 예후, 피로 골절

학 번: 2015-21994