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# The natural history of spontaneous osteonecrosis of the medial tibial plateau

K. Satku, V. P. Kumar, S. M. Chong, A. Thambyah

*From the National University of Singapore, Singapore*

**The natural history of spontaneous osteonecrosis of the medial tibial plateau remains controversial and incomplete. We have studied 21 patients (aged between 53 and 77 years) with clinical and scintigraphic features of spontaneous osteonecrosis of the medial tibial plateau who were observed prospectively for at least three years (37 months to 8.5 years). The mean duration of follow-up was 5.6 years.**

**The mean duration of symptoms at presentation was 4.7 weeks (3 days to 12 weeks). Radiographs of the affected knee at the first visit were normal in 15 patients and mildly arthritic in six. The characteristic radiographic lesion of osteonecrosis was noted at presentation in five of the mildly arthritic knees and during the evolution of the disease in eight of the radiographically normal knees. During the follow-up, subchondral sclerosis of the affected medial tibial plateau was noted in 16 knees.**

**There are three distinct patterns of outcome: 1) acute extensive collapse of the medial tibial plateau in two knees within three months of onset; 2) rapid progression to varying degrees of osteoarthritis in 12 knees, in eight within a year, in all within two years and deterioration of the pre-existing osteoarthritis in three; and 3) complete resolution in four knees, two of which were normal at presentation and two mildly osteoarthritic.**

**The two patients with acute extensive collapse and three who had rapid progression to severe osteoarthritis required total knee arthroplasty.**

**We conclude that osteonecrosis of the medial tibial plateau progresses in most cases to significant degenerative disease of the knee.**

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Spontaneous osteonecrosis of the medial tibial plateau was first described 30 years ago,[1] but despite numerous studies, its natural history remains controversial.[2-11]

The typical patient is a female over 50 years of age who presents with acute, distressing pain at rest, which often interferes with sleep and lasts for weeks to months. Maximum tenderness is over the medial tibial condyle. Radiographs may show a spectrum of changes which range from normal to varying degrees of degenerative arthritis, and the classic 'osteonecrotic lesion'.[2,3,9,10] MRI has been increasingly used to define the extent of these lesions,[9,10,12,13] but in the early stages MR scans may be negative, with the incidence of false-negative results as high as 20%.[13] The most significant and reliable imaging technique is bone scintigraphy which shows increased uptake of the isotope by the medial tibial plateau.[2,3,14]

The reported clinical course varies from resolution to progression of symptoms.[2,3,9] Although Lotke and Ecker[3] and Lotke et al[10] suggested that osteonecrosis of the medial tibial plateau may result in the development of degenerative joint disease, the nature of the deterioration and its incidence have not been clearly defined.

We have studied 21 patients with clinical and scintigraphic features characteristic of osteonecrosis of the medial tibial plateau who were followed for three to 8.5 years in order to investigate the natural history of this condition.

## Patients and Methods

There were three men and 18 women with a mean age of 65 years (53 to 77). In all 21 patients, symptoms had been present for less than 12 weeks. For each the following clinical features were identified: age, gender, involved knee, duration of symptoms, perceived history of trauma, pattern of onset and nature of pain, including whether it was constant in character and if it occurred at night thus disturbing

K. Satku, FRCS, Professor
V. P. Kumar, FRCS, Professor
A. Thambyah, MSc, Research Fellow
Department of Orthopaedic Surgery
S. M. Chong, MD, Associate Professor
Department of Pathology
National University of Singapore, 5 Lower Kent Ridge Road, Singapore 119074.

Correspondence should be sent to Professor K. Satku.


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**Table I.** Details of and findings in 21 patients with osteonecrosis of the medial tibial plateau

| Case | Age (yrs) | Gender | Degenerative changes on initial radiograph (affected knee) | Duration of symptoms before initial presentation (wks) | Developed osteonecrotic lesion | BMD* (T-score) | Time to first observation of degenerative changes (mths) | Total follow-up time (mths) | Degenerative changes at final review |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 67 | F | None | 2.0 | No | -3.73 | NA† | 96 | None |
| 2 | 62 | M | Mild | 4.0 | Yes | -2.65 | NA | 96 | Collapse (TKR)‡ |
| 3 | 75 | F | None | 2.0 | Yes | -3.38 | 11 | 102 | Severe (TKR) |
| 4 | 57 | F | None | 2.0 | Yes | -1.32 | 24 | 68 | Moderate |
| 5 | 67 | F | Mild | 6.0 | Yes | -0.69 | NA | 53 | Severe (TKR) |
| 6 | 65 | F | None | 4.0 | No | -4.05 | NA | 39 | None |
| 7 | 53 | F | None | 4.0 | No | -2.26 | 5 | 58 | Moderate |
| 8 | 57 | F | None | 2.0 | Yes | -3.31 | 5 | 96 | Severe |
| 9 | 72 | F | None | 12.0 | No | -0.90 | 9 | 67 | Mild |
| 10 | 65 | M | None | 4.0 | Yes | -3.29 | 4 | 37 | Moderate |
| 11 | 72 | F | None | 8.0 | Yes | -3.12 | 4 | 92 | Severe (TKR) |
| 12 | 70 | F | None | 2.0 | Yes | -3.72 | 3 | 44 | Severe |
| 13 | 77 | F | None | 2.0 | No | -3.65 | 14 | 60 | Mild |
| 14 | 69 | F | None | 4.0 | No | -2.52 | NA | 94 | Collapse (TKR) |
| 15 | 67 | M | None | 0.5 | Yes | -2.05 | 12 | 80 | Moderate |
| 16 | 66 | F | None | 0.5 | Yes | -1.94 | 24 | 92 | Moderate |
| 17 | 55 | F | None | 8.0 | No | -2.50 | 15 | 55 | Moderate |
| 18 | 54 | F | Mild | 12.0 | Yes | -2.76 | NA | 51 | Mild |
| 19 | 61 | F | Mild | 8.0 | Yes | -3.28 | NA | 51 | Mild |
| 20 | 74 | F | Mild | 8.0 | No | -1.95 | NA | 64 | Moderate |
| 21 | 63 | F | Mild | 3.0 | Yes | -2.65 | NA | 47 | Moderate |

*bone mineral density
†not applicable
‡total knee replacement

sleep. Other information included a history of treatment with steroids, an excessive alcohol intake and the presence of decompression sickness, a collagen disease or an organ transplant.

At examination, the presence of a flexion deformity, the site of maximum tenderness, the presence of an effusion, and the range of movement were noted. The imaging studies included weight-bearing anteroposterior, lateral and patello-femoral axial radiographs of both knees. This was followed by a bone scan. When indicated, additional investigations included CT or tomography. Seven patients also had MRI to define the extent of the lesion.

All patients were advised to minimise mechanical stress on the involved knee and to use a walking aid. Analgesics were prescribed. Patients were initially reviewed at intervals of about a month, depending on the severity of the symptoms, and later at six-monthly intervals. Radiographs were taken at first presentation, later when necessary, and at final review. When the disease progressed and surgical intervention became necessary, the specimen from the involved plateau was sent for histological examination.

## Results

Table I gives details of the findings. All patients had an acute onset of pain. The mean duration of symptoms at presentation was 4.7 weeks (3 days to 12 weeks). Eight patients presented with a history of minor trauma such as misjudging a step and landing heavily on the foot. Constant pain was the feature of all. Night pain which disturbed sleep was present in 11 patients. None had a history of treatment with steroids, excessive alcohol intake, a collagen disease, decompression sickness or an organ transplant.

Examination of the knee showed restriction of movement in five patients, in three of whom there was a flexion deformity ranging from 5° to 10°. Attempted extension of the knee in these three patients caused extreme pain. In two patients knee flexion was limited to 120°. Thirteen knees had a mild effusion. All patients had considerable tenderness over the medial tibial condyle but none had tenderness over the corresponding medial femoral condyle.

Radiographs at presentation revealed a normal tibiofemoral joint in 15 patients and mild narrowing of the medial compartment by <25% in six. Five of these had a typical osteonecrotic lesion on radiographs at presentation (Fig. 1), while eight of the 15 patients with normal knees developed the lesion during follow-up.

The bone scan which was performed within one week of presentation showed an increased uptake in the medial tibial condyle of the involved knee in all 21 patients. Seven patients had MRI which confirmed the clinical diagnosis.

**Outcome in the 15 normal knees.** Two knees were unchanged at final follow-up. Twelve progressed rapidly to varying degrees of osteoarthritis within 24 months (Table I). Subsequent progression of the osteoarthritis was gradual (Fig. 2). At the final review two had mild joint-space nar-


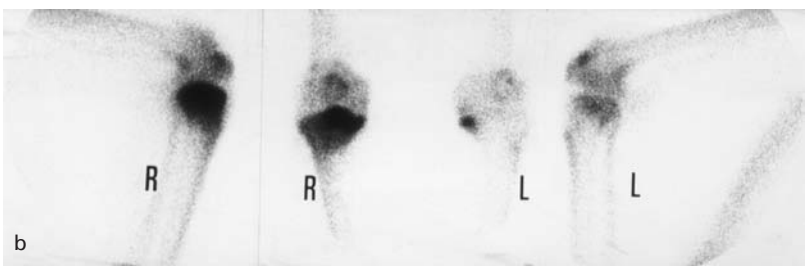


Fig. 1

Figure 1a – Weight-bearing anteroposterior (AP) radiograph showing mild osteoarthritis and the osteonecrotic lesion at presentation. Figure 1b – Bone scans at presentation showing increased uptake in the right medial tibial condyle. Figure 1c – Anteroposterior radiograph two months later showing fracture and collapse of the medial tibial plateau.


Fig. 2

Figure 2a – Normal weight-bearing radiograph of the right knee at presentation. Figure 2b – Two years later showing narrowing of the joint space. Figure 2c – A further four years later showing minimal progression of the osteoarthritis of the affected knee and a relatively normal left knee.

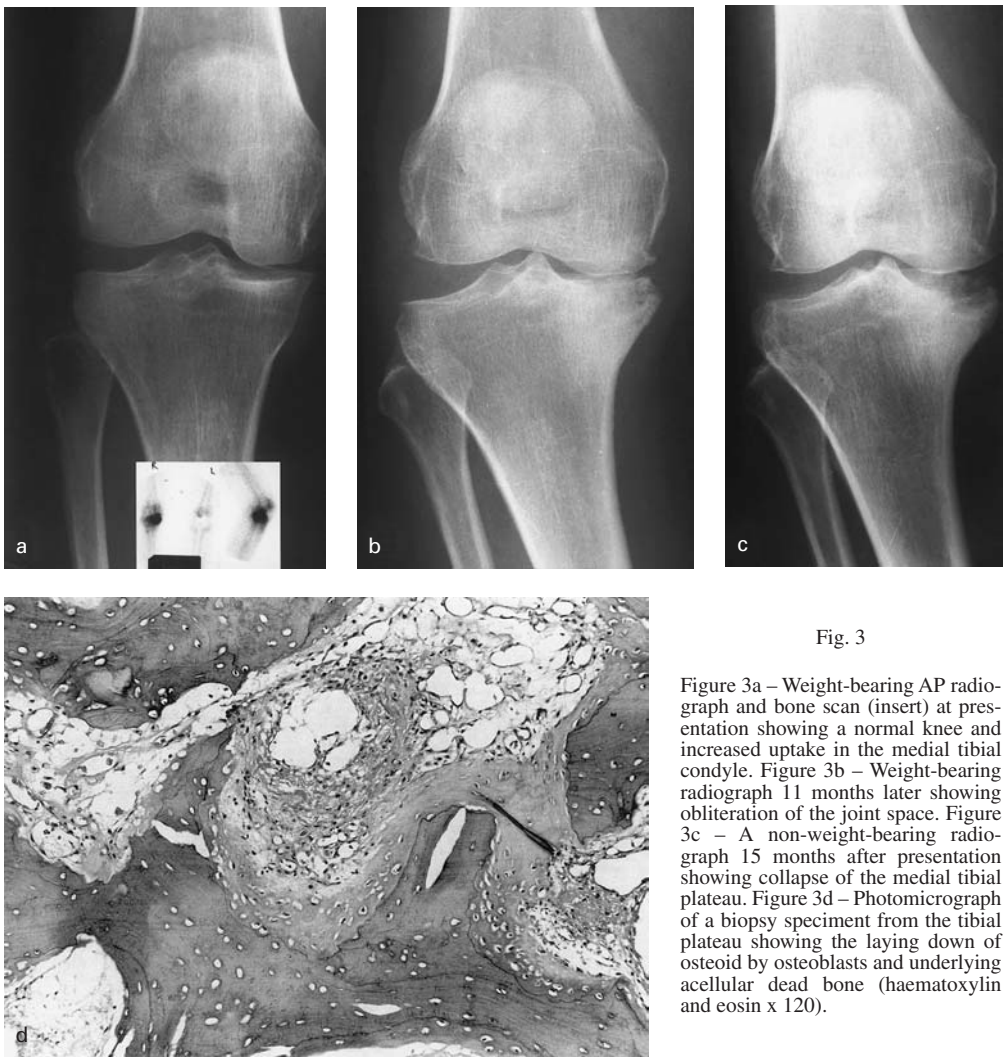


Fig. 3

Figure 3a – Weight-bearing AP radiograph and bone scan (insert) at presentation showing a normal knee and increased uptake in the medial tibial condyle. Figure 3b – Weight-bearing radiograph 11 months later showing obliteration of the joint space. Figure 3c – A non-weight-bearing radiograph 15 months after presentation showing collapse of the medial tibial plateau. Figure 3d – Photomicrograph of a biopsy speciment from the tibial plateau showing the laying down of osteoid by osteoblasts and underlying acellular dead bone (haematoxylin and eosin x 120).

rowing of <25%, six moderate joint-space narrowing of 25% to 75%, and four severe osteoarthritis (Fig. 3). Two of the latter required total knee replacement. The last patient in this group developed acute collapse of the medial tibial plateau within three months of the onset of symptoms and required an arthroplasty at 14 months.

**Outcome in the six knees with mild osteoarthritic changes.** Two patients had no radiographic deterioration and two progressed to moderate osteoarthritis. One developed severe degenerative changes and the last had acute collapse of the medial tibial condyle within three months of the onset of symptoms (Fig. 1). Both of these required joint replacement.

## Discussion

The precise nature of the initiating event of osteonecrosis of the medial tibial plateau is not clear. The two most considered suggestions are a primary vascular incident or a subchondral stress fracture with a secondary intraosseous compartment syndrome and osteonecrosis.[3,9] In our study and in other reports the findings of an initial minor injury in some cases, an increased prevalence of osteoporosis (66%, Table I) compared with that in a similar age group[15] and the development of subchondral sclerosis in the ensuing months as in a healing fracture[16] suggest that the initiating event could be an insufficiency fracture. This is supported by findings of Yamamoto and Bullough[17] who described features of fracture in specimens of osteonecrosis of the femoral condyle. While the characteristic pain may be thought to be inconsistent with a mechanical lesion such as an insufficiency fracture, we support the hypothesis that the intense pain is due to the development of a subchondral intraosseous compartment syndrome after a fracture within the highly innervated subchondral bone. Arnoldi, Lemperg and Linderholm[18] noted that there is a close relationship between proximal tibial rest pain and intraosseous hypertension. The latter may lead to osteonecrosis.

Our study is unique in that there was a preponderance of radiologically normal tibiofemoral joints (71%) at the initial

presentation, similar to that reported for osteonecrosis of the medial femoral condyle.[19-21] This is contrary to most previous studies on osteonecrosis of the tibial plateau. In the series of Houpt et al,[2] Lotke and Ecker,[3] Ecker and Lotke[9] and Lotke et al[10] only 40%, 22%, 25% and 12%, respectively, of knees were normal when the patients were first seen.

The rapid progression to osteoarthritis, within a year, in most cases (Table I), is also a feature not reported in tibial osteonecrosis although it has been reported in osteonecrosis of the medial femoral condyle.[19-21] If patients are seen late, the degenerative changes which may have developed since the onset of symptoms may be assumed to be the starting point of the disease process. Late presentation masks the true state of the involved knee at the onset of the disease. Rozing et al[21] drew attention to this when describing the radiographic features at the onset of osteonecrosis of the medial femoral condyle. In our study in which patients presented with a duration of symptoms of up to five weeks, four had developed marked osteoarthritis within five months of presentation (cases 7, 8, 10 and 12, Table I). The mild osteoarthritis noted in some of our patients at presentation, in whom the duration of symptoms ranged from 4 to 12 weeks, could also be due to a late presentation with degenerative changes already present.

In most reported studies, the duration of symptoms at presentation is lacking, which could explain the observed differences in the radiographic state at presentation and the subsequent largely benign course of the disease.[2,3,9] Houpt et al[2] reviewed 21 knees and noted that 15 had varying degrees of osteoarthritis at presentation. At final review information was available on only 12 knees, and progression of the degenerative changes was observed in only one. Based on this observation they concluded that osteonecrosis of the medial tibial plateau did not appear to accelerate the development or progression of osteoarthritis of the knee.

Lotke and Ecker[3] reviewed 36 patients with similar clinical symptomatology and scintigraphic findings and noted that eight knees were normal, 22 had mild and six moderate osteoarthritic changes at presentation. The symptoms resolved after nine to 12 months in all except three knees. The duration of symptoms at presentation was not available. Hence, the high incidence of degenerative changes at presentation and the lack of apparent progression could be because the degenerative process, if any, had already taken place and there was little further progression. In a subsequent review Ecker and Lotke[9] noted mild osteoarthritic changes in three and moderate osteoarthritic changes in nine of 16 knees studied. Fourteen of these patients required surgery or had surgery recommended for severe symptoms. It is not clear if the severe symptoms were associated with progressive osteoarthritis or collapse of the acute osteonecrotic lesion. Again, the duration of symptoms before presentation was not indicated, making it difficult to accept the reported presentation as the true radiographic state of the knee at the onset of the disease process.

In a recent report, however, Lotke et al[10] have highlighted the duration of symptoms at presentation. This varied between one and 22 months with a mean of six months. However, even this may be too late and radiographic changes may have occurred where there were none before. Although we cannot be certain that this event takes place only in radiographically normal knees, we have not been able to show any patients with established moderate or severe osteoarthritis presenting with acute symptoms and with scintigrams suggestive of osteonecrosis of the medial tibial plateau.

The short duration of symptoms at presentation and the lengthy follow-up of our patients has given us an opportunity to determine the evolution of the disease. Based on our observations, the outcome after the 'osteonecrotic event' can be categorised into one of the following:

1) *Resolution*. Four of the 21 patients had complete resolution. Two had normal radiographs and two mild osteoarthritic changes at their first presentation.

2) *Progression to osteoarthritis*. In 15 the osteoarthritis had developed or progressed during the follow-up. In this category we have included three patients who had mild osteoarthritis at presentation. Two subcategories may be further defined: a) a group with rapid obliteration of the joint space and varying degrees of collapse of the tibial plateau, all taking place acutely over a period of one to two years (Fig. 3); and b) those with a less severe outcome in which there is progression to mild or moderate osteoarthritis with stabilisation and subsequent gradual progression, no different from primary osteoarthritis (Fig. 2).[22]

3) *Extensive acute collapse of the tibial plateau*. This occurred in two knees within a few months of onset (Fig. 1). The symptoms were disabling and required urgent surgical intervention.

Although we were not able to identify any features at initial presentation which may suggest a poor prognosis, we agree with Ecker and Lotke[9] that the radiographic appearance of an osteonecrotic lesion suggests probable further symptoms and progressive osteoarthritis.

Our study has highlighted the involvement of normal or nearly normal knees. There is a rapid onset of varying degrees of osteoarthritis in most cases. Osteonecrosis is therefore not a completely benign lesion as has been implied by previous work.[2,3]

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

## References


1. **D'Angeljan G, Ryckewaert A, Glimet S, et al**. Osteonecrose du plateau tibial interna. *Extr Rheumat* 1976;8:253-5.
2. **Houpt JB, Alpert B, Lotem M, et al**. Spontaneous osteonecrosis of the medial tibial plateau. *J Rheumat* 1982;9:81-90. As quoted in Osteonecrosis of the medial part of the tibial plateau by Ecker ML, Lotke PA: see reference 9.
3. **Lotke PA, Ecker ML**. Osteonecrosis-like syndrome of the medial tibial plateau. *Clin Orthop* 1983;176:148-53.
4. **Lotke PA, Ecker M**. Osteonecrosis of the knee. *Orthop Clin North Am* 1985;16:797-808.

5. **Marmor L**. Fracture as a complication of osteonecrosis of the tibial plateau: a case report. *J Bone Joint Surg [Am]* 1988;70-A:454-7.
6. **Lotke PA, Ecker ML**. Osteonecrosis of the knee. *J Bone Joint Surg [Am]* 1988;70-A:470-3.
7. **Satku K, Kumar VP**. Spontaneous osteonecrosis of the knee. *J Korean Knee Society* 1990;2:85-8.
8. **Brahme SK, Fox JM, Ferkel RD, et al**. Osteonecrosis of the knee after arthroscopic surgery: diagnosis with MR imaging. *Radiology* 1991;178:851-3.
9. **Ecker ML, Lotke PA**. Osteonecrosis of the medial part of the tibial plateau. *J Bone Joint Surg [Am]* 1995;77-A:596-601.
10. **Lotke PA, Ecker ML, Berth P, Lonner JH**. Subchondral magnetic resonance imaging changes in early osteoarthritis associated with tibial osteonecrosis. *Arthroscopy* 2000;16:76-81.
11. **Lonner CH, Lotke PA**. Tibial osteonecrosis. *Instr Course Lect* 2001;50:477-81.
12. **Reicher MA, Bassett LW, Gold RH**. High resolution magnetic resonance imaging of the knee joint: pathologic correlations. *AJR Am J Radiol* 1985;145:903-9.
13. **Pollack MS, Dalinka MK, Kressel HY, Lotke PA, Spritzer CE**. Magnetic resonance imaging in the evaluation of suspected osteonecrosis of the knee. *Skeletal Radiol* 1987;36:121-7.
14. **Al-Rowaih A, Wingstrand H, Lindstrand A, et al**. Three-phase scintimetry in osteonecrosis of the knee. *Acta Orthop Scand* 1990;61:120-7.
15. **Melton LJ III**. Prevalence of osteoporosis: gender and radical comparison. *Calcif Tissue Int* 2001;69:179-81.
16. **Bauer G, Gustafsson M, Mortensson W, Norman O**. Insufficiency fractures in the tibial condyles in elderly individuals. *Acta Radiol Diagn (Stockh)* 1981;22:619-22.
17. **Yamamoto T, Bullough PG**. Spontaneous osteonecrosis of the knee: the result of subchondral insufficiency fracture. *J Bone Joint Surg [Am]* 2000;82-A:858-66.
18. **Arnoldi CC, Lemperg RK, Linderholm H**. Intraosseous hypertension and pain in the knee. *J Bone Joint Surg [Br]* 1975;57-B:360-3.
19. **Ahlback S, Bauer GCH, Bohne WH**. Spontaneous osteonecrosis of the knee. *Arthritis Rheum* 1968;11:705-33.
20. **Aglietti P, Insall JN, Buzzi R, Deschamps C**. Idiopathic osteonecrosis of the knee: aetiology, prognosis and treatment. *J Bone Joint Surg [Br]* 1983;65-B:588-97.
21. **Rozing PM, Insall J, Bohne WH.** Spontaneous osteonecrosis of the knee. *J Bone Joint Surg [Am]* 1980;62-A:2-7.
22. **Felson DT, Zhang Y, Hanan MT, et al.** The incidence and natural history of osteoarthritis in the elderly. *Arthritis and Rheum* 1995;38:1500-5.