



Case Series

Subtrochanteric fracture of the femur following knee replacement surgery: A case series and review of the literature

Fardis Vosoughi^a, Arash Sharafat Vaziri^b, Ramin Shayan-Moghadam^a, Erfan Babaei Nejad^{a,*}

^a Department of Orthopedic and Trauma Surgery, Shariati Hospital, School of Medicine, Tehran University of Medical sciences, Tehran, Iran

^b Center of Orthopedic Trans-Disciplinary Applied Research (COTAR), Tehran University of Medical Sciences, Tehran, Iran

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ABSTRACT

Introduction and importance: Knee arthroplasties as an effective intervention is primarily performed in patients with primary osteoarthritis and rheumatoid arthritis. Risk of hip fracture may be either decreased or increased in patients with Knee arthroplasties. There is conflicting evidence in this regard. Over the years, some studies have reported the occurrence of hip fractures following this operation as a rare but severe complication. The aim of the present case series was to report diagnosis and treatment of the mentioned five cases.

Case presentation: During a period of two years, five patients with a diagnosis of a subtrochanteric fracture and history of total knee arthroplasty who referred to hospital were selected to include in the present case series.

Clinical discussion: the presence of RA and treatment with glucocorticoids, a reduction of BMD following knee replacement surgery, and ultimately, an increase in physical activity and movement after the arthroplasty due to the improvement of preoperative pain, may all contribute in a complex manner to the observed outcome of increased fracture risk in the hip following TKA.

Conclusion: In summary, special care including using medications to improve BMD should be taken to minimize the risk of such an event.

1. Introduction

Knee arthroplasties (KAs) are effective interventions, with low mortality rates and few severe adverse outcomes [1]. The surgery is primarily performed in patients with primary osteoarthritis (OA) and rheumatoid arthritis. Knee replacement surgery is one of the most common arthroplasty surgeries, and its frequency is expected to rise as the population ages [2].

Today we know too little about the association between osteoarthritis, falls, and fractures. Several studies have reported an association between high bone mineral density (BMD) and osteoarthritis [3]. In contrast, other reports infer that both women and men with osteoarthritis also may have osteoporosis or osteopenia and an increased risk of falls and fracture [4].

Hip fractures are related to a high mortality rate and reduced physical function. Risk factors for hip fracture include age, height, genetic factors, and lifestyle factors such as physical inactivity, diet, alcohol consumption and smoking, a low body mass index (BMI), low BMD, and hip geometry [5].

Risk of hip fracture may be either decreased or increased in patients

with KA or OA [1]. In frail elderly patients, KA may protect against hip fracture by reducing the occurrence of falls. On the other hand, within the first month after KA, muscle strength is often decreased, which can elevate fracture risk [6].

Over the years, some studies have reported the occurrence of hip fractures following this operation as a rare but severe complication [7–9]. A British study found that the risk of hip fracture was increased by 58 % (after adjusting for age, gender, BMI, smoking, and alcohol intake) the first year after TKR, a finding that was supported by a Dutch study, which found that the probability of a hip fracture increased with 54 % after TKR.

While few studies concerning the reason exist, a possible explanation might be an observed reduction in the bone density of the hip, which seems to peak at about six to twelve months after the surgery [10]. The present study is a presentation of five such cases presented to our center during a period of two years, as well as a concise literature review.

2. Method

During a period of two years, five patients with a diagnosis of a

* Corresponding author at: Department of Orthopedic and Trauma Surgery, Tehran University of Medical Sciences, Iran

E-mail address: erfan_8474@yahoo.com (E.B. Nejad).

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subtrochanteric fracture and history of total knee arthroplasty (TKA) who referred to Shariati hospital were selected to include in the present case series. The present study has been reported in line with the PRO-CESS criteria [11].

3. Case presentation

3.1. Case 1

A fifty-five-year-old female with a history of rheumatoid arthritis (RA) presented to the clinic with severe pain in the right hip, preventing walking and weight bearing. She reported having had the pain since the previous week without any apparent trauma. The pain had intensified in the last two days. A diagnosis of a subtrochanteric fracture (Russell-Taylor classification of 1A) was confirmed via radiographs (Fig. 1). She gave a history of bilateral TKA nearly one year ago, as well as a previous right subtrochanteric hip fracture following a fall from the stairs approximately four months ago, treated at the time with a dynamic condylar screw (DCS) after which she had been ambulatory with the aid of a walker. The patient used prednisolone, Methotrexate, Sulfasalazine, Hydroxychloroquine and Alendronate. Upon physical examination, scars from previous surgeries were observable on both the right hip and the anterior of both knees. The patient had tenderness in the right hip and was incapable of weight-bearing or walking. Also, the patient could not perform a straight leg rise (SLR) test. The remainder of the neurovascular examination was unremarkable. Also, physical activity level of this patient was evaluated by a validated international physical activity questionnaire-short form (IPAQ-SF). Total metabolic equivalents (MET-minutes/week) score was computed based on guidelines for data processing and analysis of the IPAQ, and she was classified as a subject with moderate physical activity [12].

3.2. Case 2

A 67-year-old female presented to the emergency department with a complaint of pain and restricted range of motion in her right hip. The patient gave a history of a ground-level fall; after which she could not walk. The patient had been ambulatory prior to the trauma. She had a history of hypertension and RA and had undergone right TKA nearly seven months ago. At the time of presentation, the patient reported receiving Prednisolone, Hydroxychloroquine, Azathioprine, and other medications for hypertension. The patient reported pain in the right inguinal area, could not perform an SLR test, and was not weight-bearing. Dorsiflexion of the ankle and the big toe were possible, and the neurovascular examination proved normal. A diagnosis of subtrochanteric fracture (Russell-Taylor classification of 1 A) was confirmed via the obtained radiographs (Fig. 2). Also, physical activity level of this patient was evaluated by a validated international physical activity questionnaire-short form (IPAQ-SF). Total metabolic

equivalents (MET-minutes/week) score was computed based on guidelines for data processing and analysis of the IPAQ, and she was classified as a subject with low physical activity [12].

3.3. Case 3

A 79-year-old female presented to the ED following a ground-level fall with a complaint of pain and limited range of motion in her right hip. She walked independently prior to the trauma. The patient gave a history of right knee TKA 18 years ago and a right hallux valgus surgery five years ago. She also had a history of RA and hypertension and had experienced a cerebrovascular accident two years ago. At the time of presentation, the patient received Prednisolone, Methotrexate, and Clopidogrel but no Alendronate. The inguinal area was painful upon examination. She could not bear weight or perform SLR, and the neurovascular exam was unremarkable. A subtrochanteric (Russell-Taylor classification of 1B) fracture diagnosis was achieved via radiography (Fig. 3). Also, physical activity level of this patient was evaluated by a validated international physical activity questionnaire-short form (IPAQ-SF). Total metabolic equivalents (MET-minutes/week) score was computed based on guidelines for data processing and analysis of the IPAQ, and he was classified as a subject with low physical activity [12].

3.4. Case 4

A 78-year-old female presented to the clinic for an unrelated complaint. She gave a history of bilateral TKA five years ago, a left femoral shaft fracture two years ago for which the patient had undergone minimally invasive plate osteosynthesis (MIPO), and a subtrochanteric peri-implant fracture of the left distal femur (Russell-Taylor classification of 1A) treated with implant removal and proximal femoral nail anti-rotation (PFNA) approximately 18 months ago (Fig. 4). The patient did not report any additional comorbidities and did not receive any particular medications. Upon physical examination, the patient was weight-bearing and could walk with the help of a walker. Neurovascular examination proved normal. Also, physical activity level of this patient was evaluated by a validated international physical activity questionnaire-short form (IPAQ-SF). Total metabolic equivalents (MET-minutes/week) score was computed based on guidelines for data processing and analysis of the IPAQ, and she was classified as a subject with low physical activity [12].

3.5. Case 5

A 72-year-old female presented to the ED following a ground-level fall with a complaint of pain in her left hip. The patient had a history of bilateral knee TKA 5 years ago. She also had a history of asthma and hypertension and was not receiving any particular medications. The inguinal area was painful upon examination. She was unable to bear

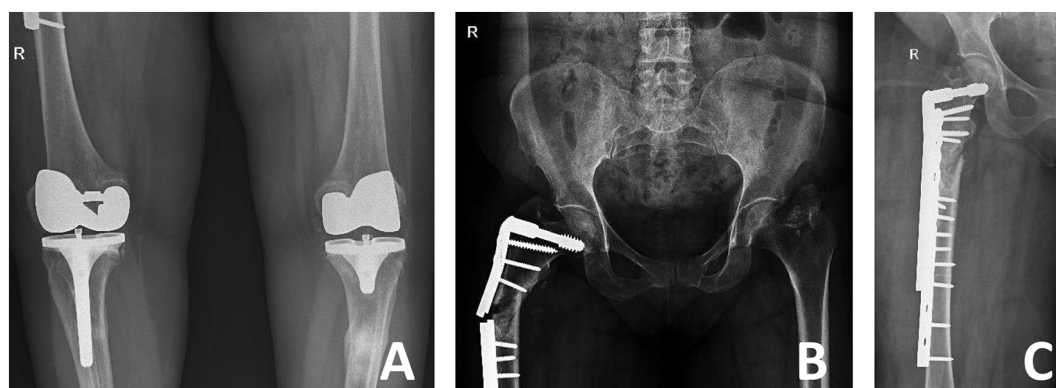


Fig. 1. Case 1: A) Bilateral TKA. B) Fracture of the hip. C) Final result of the surgery.

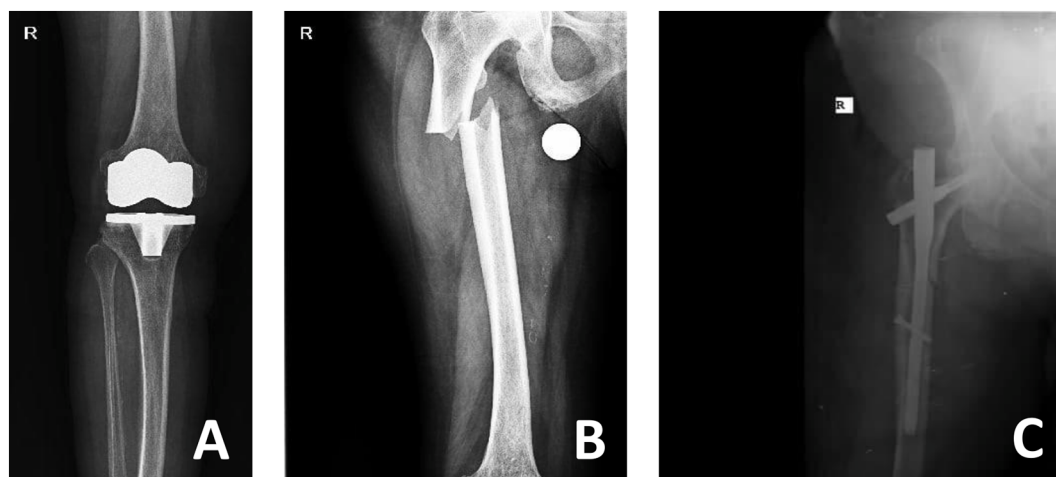


Fig. 2. Case 2: A) right TKA. B) Fracture of the hip. C) Final result of the surgery.

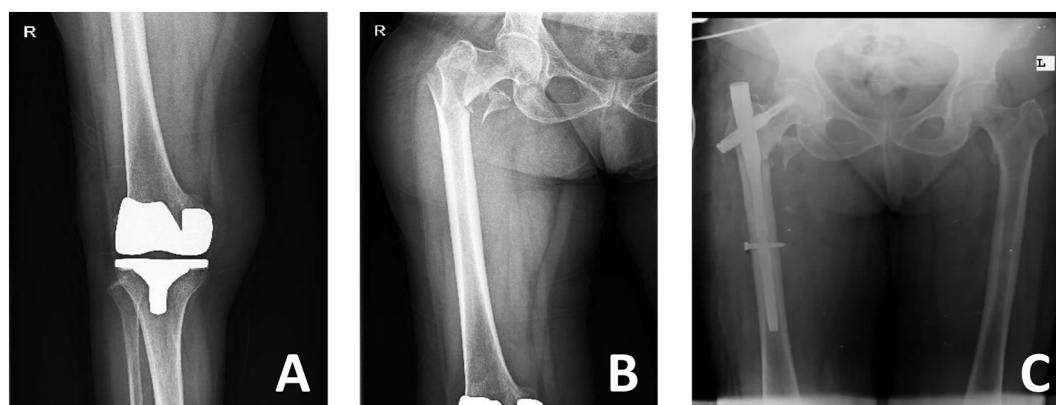


Fig. 3. Case 3: A) Right TKA. B) Fracture of the hip. C) Final result of the surgery.

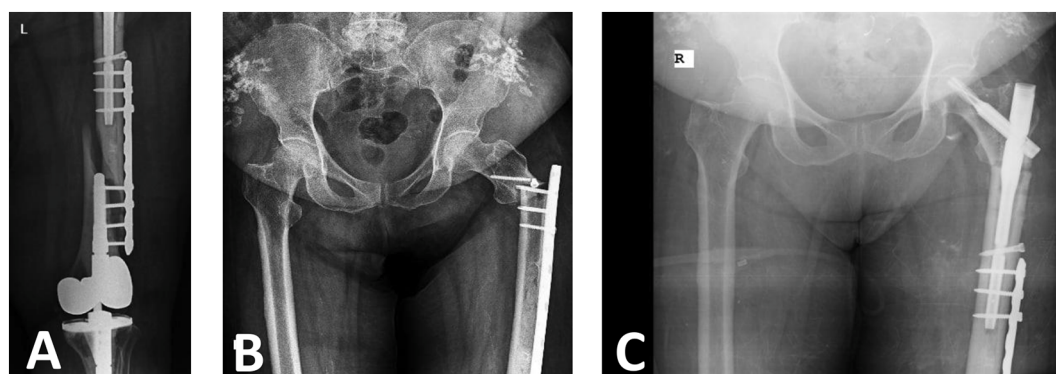


Fig. 4. Case4: A) TKA and Femoral shaft fracture. B) Fracture of the hip. C) Final result of the surgery.

weight or perform SLR. A diagnosis of left subtrochanteric fracture (Russell-Taylor classification of 1A) was achieved via radiography (Fig. 5). Patients' information is further summarized in Table 1. Also, physical activity level of this patient was evaluated by a validated international physical activity questionnaire-short form (IPAQ-SF). Total metabolic equivalents (MET-minutes/week) score was computed based on guidelines for data processing and analysis of the IPAQ, and she was classified as a subject with moderate physical activity [12].

4. Discussion

Fractures of the femur are classified into intracapsular and extracapsular, with the latter further classified into intertrochanteric and subtrochanteric fractures [13]. Considered a challenge in geriatric populations, subtrochanteric fractures are usually treated via antegrade intramedullary nailing, and studies suggest immediate surgery is important in achieving favourable results [13–15].

Subtrochanteric hip fracture following TKA is considered a severe but rare occurrence. Until about a decade ago, much of the available

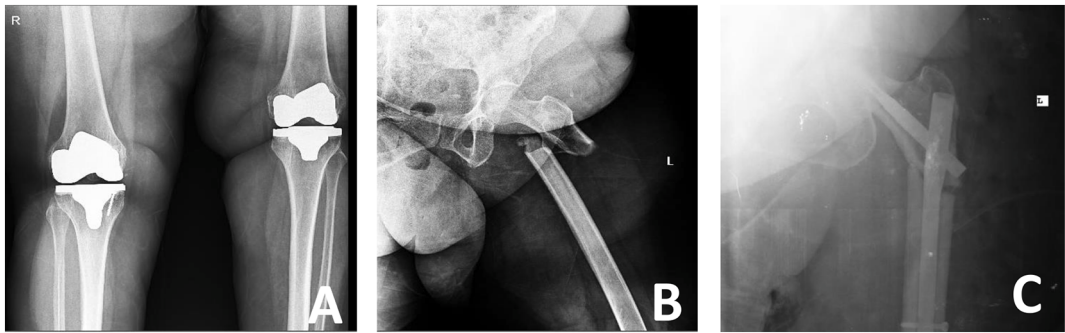


Fig. 5. Case 5: A) Right TKA. B) Fracture of the hip. C) Final result of the surgery.

Table 1
Summary of patients' information.

Case No.	Age	Fracture side	Deformity	History of RA	Presence of trauma	The time between arthroplasty and fracture	Type of treatment	Length of IMN
1	55	Right	Varus	Yes	No	12 months	IMN	20 cm
2	67	Right	Varus	Yes	Yes	7 months	IMN	22 cm
3	79	Right	Varus	Yes	Yes	18 years	IMN	22 cm
4	78	Left	Varus	No	No	3.5 years	IMN	21 cm
5	72	Left	Varus	No	Yes	5 years	IMN	20 cm

information regarding this association was limited to a handful of case reports [7–9,16,17]. The first case report of a hip fracture following TKA in a patient with osteoarthritis was published in 1997. In the study, the reduced tension band effect of the iliotibial tract and an increase in physical activity following long periods of inactivity combined with a general change in the dynamic and static forces acting on the femur were hypothesized to be involved [18].

In recent years, and considering the possible association of TKA with an increase in hip fractures, several studies have investigated such a possibility. Of these, one of the largest studies was a population-based case-control study by Lalmohamed et al. in which more than 33,000 individuals were investigated. The study showed a clear association between TKA and hip fracture with an odds ratio of 1.54 (95 % CI 1.19–2.00) [1]. Another major study in Britain involved more than 120,000 individuals and reported that the risk of hip fracture increased after TKA for about a year, after which it decreased again to values near normal approximately three years after the surgery [19].

Another interesting finding in both studies mentioned above was that both reported younger age to be correlated with a higher incidence of hip fracture in those with a history of TKA [1,19]. While contradictory based on the age of our patients, A possible explanation for such an observation might be higher levels of physical activity in younger patients [1,19]. Furthermore, it was found that a longer duration of living with osteoarthritis prior to the operation was correlated with lower fracture rates [19]. Such a finding is particularly interesting as it may be that the patients with a longer history of osteoarthritis may have adopted a more sedentary lifestyle.

In another study on post-menopausal women, following the observation that chances of fracture increased following TKA, it was speculated that the increase in fracture rates might be due to a decrease in BMD and muscle loss following the surgery [20]. Such a finding is especially important as several studies have reported a reduction in BMD following knee replacement surgery. In a study by Beaupre and others, BMD in the hip decreased after TKA until approximately one year after the surgery [21]. Others reported BMD in the hip to be lower than normal, even 2 to 5 years after the surgery [22]. Soininvaara and colleagues found BMD lower even in the contralateral knee following knee replacement [23]. Finally, in a systematic review and meta-analysis by Prince et al., hip BMD decreased after the surgery for about six months and remained lower than normal for extended periods [24]. The BMD reduction after TKA might be explained by stress-adaptive bone

remodeling (stress-protective effect). This stress-protective effect is considered the primary determinant of BMD reduction in the early postoperative phase [25]. Also, it has been suggested that immobilization and stress shielding effect of the femoral component might contribute to a generalized loss of BMD in the lower extremity after TKA [25].

An interesting finding in our case series was that three out of five patients had a history of RA and received glucocorticoids. This is particularly important as the reduction of bone density as an adverse effect of glucocorticoid use in RA treatment is well established. A systematic review and meta-analysis including 15 observational studies and more than 45,000 individuals concluded that glucocorticoid use, especially at a dose of more than 5 mg per day and for more than five years, was significantly correlated with a lower BMD both in the hip and the spine and higher probability of fracture. Interestingly, BMD was not significantly different in those with RA compared with the normal population, signifying the role of glucocorticoid use in reducing BMD [26]. Another systematic review, including 13 studies, found RA associated with higher fracture risks in men and women [27]. Intriguingly, a meta-analysis of 7 randomized trials found a short duration of RA or glucocorticoid treatment to have no significant effect on the BMD. Therefore, a long disease duration and glucocorticoid treatment might be essential to make the patients more susceptible to fracture [28].

While presenting five cases of subtrochanteric fractures with a previous history of arthroplasty, the present study is limited by the few subjects, which renders any statistical analysis impossible. Also, as another limitation of this study, the suggested age range for this phenomenon is less than 71 years old, whereas three of the cases in the present case series were older. On the other hand, the overall results seem to be in agreement with the present body of literature and therefore may add to the credibility of the proposed factors contributing to the phenomenon.

5. Conclusion

Overall, considering the discussed cases and based on the reviewed literature, the presence of RA and treatment with glucocorticoids, a reduction of BMD following knee replacement surgery, and ultimately, an increase in physical activity and movement after the arthroplasty due to the improvement of preoperational pain, may all contribute in a complex manner to the observed outcome of increased fracture risk in

the hip following TKA. Also, an important fact to keep in mind is that the occurrence of hip fracture after major surgery, such as TKA, has been found to have a significantly negative impact on the patient's quality of life and overall function [20,29]. Therefore, special care should be taken to minimize the risk of such an event. Using medications including alendronate to improve BMD, treatment of patients with RA with medications other than glucocorticoids, and application of some new types of knee prosthesis to attenuate decreasing BMD are among the most important strategies for reducing the risk of subtrochanteric fracture of the femur. Further studies are warranted to illustrate better the mechanisms involved in the phenomenon.

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There is no founder for this study.

Ethical statement

This study was approved by Ethical Committee of Tehran University of Medical Sciences on 17 February 2022.

Registration of research studies

N/A.

CRedit authorship contribution statement

FV develop the idea for this study, ASH and RSH collect the data, and EB wrote the whole manuscript and revised.

Ethical approval

This study was approved by ethical committee of Tehran University of Medical Sciences on 17 February 2022.

Consent

Written informed consent was obtained from the patient for publication and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Guarantor

Not applicable.

Declaration of competing interest

There is no conflicts of interest.

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