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Case Report

Nonsurgical management of atraumatic early distal femoral periprosthetic insufficiency fracture after primary total knee arthroplasty, a report of two cases

Ahmed M. Abdelaal^a, Ahmed A. Khalifa^{a,b,*}^a Orthopaedic and Traumatology Department, Assiut University Hospital, Assiut, Egypt^b Orthopedic Department, Qena Faculty of Medicine and University Hospital, South Valley University, Qena, Egypt

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ABSTRACT

Periprosthetic distal femoral fractures after primary total knee arthroplasty (TKA) are considered rare; however, they pose a challenge for the treating surgeon, and the management options are mostly surgical (open reduction and internal fixation or revision surgery). We present two female patients who developed atraumatic lateral femoral condyle fractures three weeks after primary TKA; both were treated nonsurgically with acceptable outcomes and patient satisfaction. We believe that nonsurgical management of periprosthetic distal femoral fractures could be an economical solution in selected cases; it also could help maintain the distal femoral bone stock till a revision surgery is performed.

Background

Periprosthetic fractures (PPF) following total knee arthroplasty (TKA) are considered rare complications that occur at an incidence of 0.5% to 4% [1,2]; however, they pose a significant burden on the surgeon as well as the patient [3]. Commonly, it affects the distal femur, which could occur perioperatively or late after several years following trivial trauma, especially in osteoporotic bone [3,4].

For a distal femoral PPF to occur, predisposing factors could be present, either related to the patient, such as osteopenia and neurological disorders (with increased risk of repeated falls), or surgical factors such as anterior femoral notching [3,4]. The time interval for the occurrence of this type of fracture after the index surgery ranged between 25.5 and 70 months [5,6]; however, early atraumatic insufficiency fractures were rarely reported in the literature as well as being less explained [1,7,8].

The management options vary from conservative nonsurgical lines, open reduction and internal fixation (ORIF), and revision surgery [3,5]. Which option to choose depends on patient factors, fracture classification, surgeon competency, and availability of special implants and fixation devices [9].

We present two cases of early postoperative distal femoral insufficiency PPF after primary TKA, which were treated nonsurgically with acceptable early outcomes.

* Corresponding author at: Orthopedic Department, Qena Faculty of Medicine and University Hospital, South Valley University, Kilo 6 Qena-Safaga Highway, Qena 83523, Egypt.

E-mail addresses: aabdelaal61@yahoo.com (A.M. Abdelaal), ahmed_adel0391@med.svu.edu.eg (A.A. Khalifa).

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Clinical cases

Primary TKA was performed for two female patients (diagnosed with end-stage knee osteoarthritis not responding to nonsurgical management) by the same surgeon (first author, who has over 15 years of arthroplasty surgery experience). In both patients, the surgery was performed under spinal anesthesia, using a tourniquet, through a medial parapatellar approach, using a posterior stabilized (PS) total knee prosthesis (NexGen LPS fixed knee, Zimmer Inc., Warsaw, IN, USA) aiming at neutral knee alignment (measured in a short anteroposterior knee radiograph as an anatomical tibiofemoral (aTF) angle of $187^\circ \pm 3$ of valgus) and the distal femoral cut was determined to be $7^\circ \pm 2$ valgus in relation to the anatomical femoral axis (which results in a coronal plane femoral component alignment of $85^\circ \pm 2$ as measured by the anatomical lateral distal femoral angle (aLDFA)) [10]. The postoperative rehabilitation protocol was the same for both patients, entailing early mobilization and early knee motion from the second postoperative day under the supervision of a physiotherapist.

Patient #1

65 years old, her BMI was 24 kg/m^2 , and she had no medical comorbidities. She complained of both knees equally, which had bilateral varus deformity of 15° and 12° according to aTF angle (Fig. 1A). Bilateral TKA was performed in the same session (femoral component was size C in both knees), the surgery went unremarkable, and no intraoperative complications were noted. Immediate postoperative radiographs showed restoration of the anatomical axis of the knee (aTF angle was 186° and 187° for the right and left knees, respectively), and the femoral components were positioned correctly as the aLDFA was 83° and 85° for the right and left knees respectively (Fig. 1B). She presented for suture removal after two weeks without complaint; one week later, she presented with left knee pain, inability to bear weight, progressive knee valgus deformity, and no history of trauma. The radiographic evaluation showed lateral femoral condyle PPF with a valgus deformity of the knee (aTF angle was 191° , and the aLDFA was 81°) (Fig. 2A). The patient was consulted for revision surgery; however, she refused, and a conservative line of management was prescribed for six weeks in the form of a long leg hinged knee brace to be placed the whole day; the patient could flex the knee up to 90° , and strict non-weight bearing. Follow up radiographs every two weeks to confirm the position of the prosthesis and no progression of the deformity.

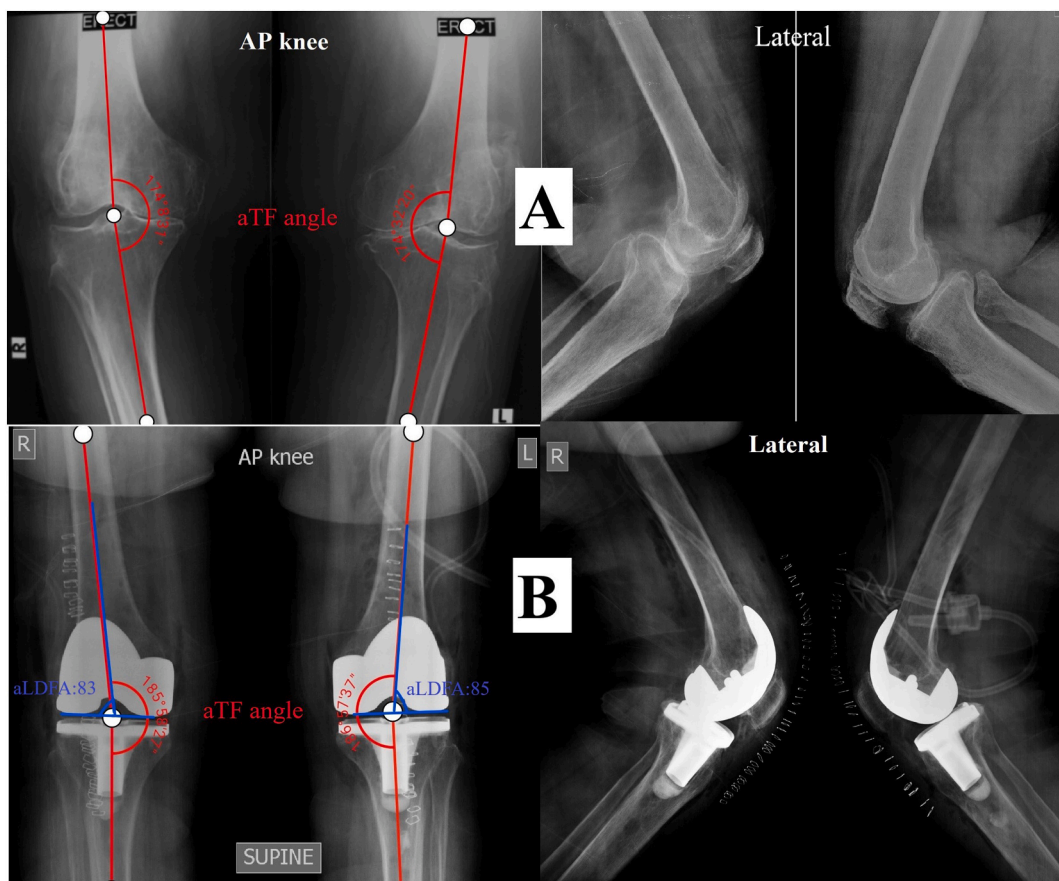


Fig. 1. Patient #1. A, Preoperative anteroposterior and lateral views of her knees bilaterally. B, immediate postoperative after bilateral TKA (aTF: anatomical tibiofemoral angle, aLDFA: anatomical lateral distal femoral angle).

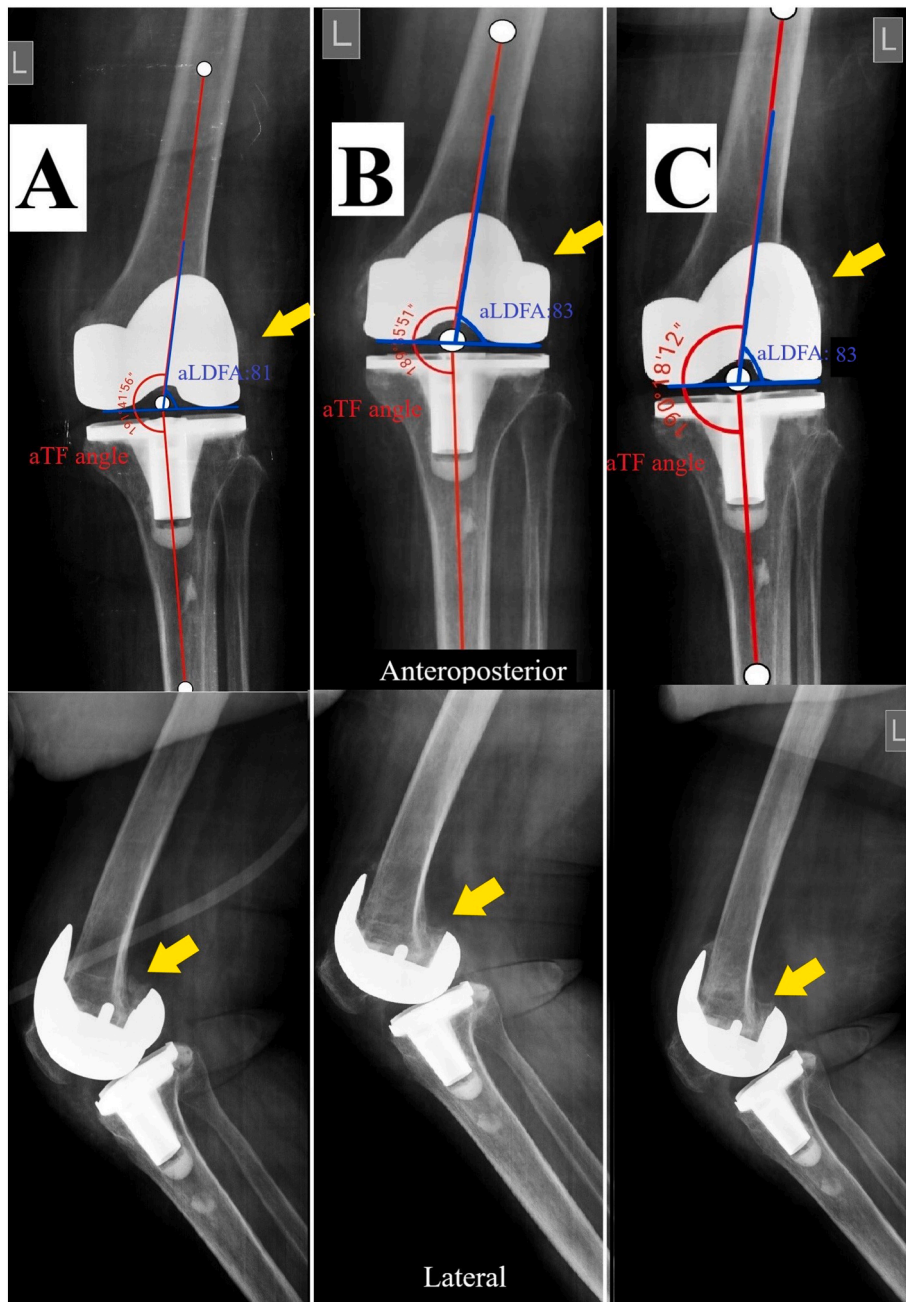


Fig. 2. Follow up anteroposterior and lateral radiographs of patient #1 left TKA. A, At three weeks postoperative showing valgus deformity of the knee, lateral distal femoral condyle fracture is indicated by the yellow arrowhead. B and C, Follow up at six weeks and six months, respectively, showing maintained limb and femoral component alignment (indicated by aTF and aLDFA angles) and healing of the fracture (yellow arrowhead) (aTF: anatomical tibiofemoral angle, aLDFA: anatomical lateral distal femoral angle).

Signs of healing were observed on the six-week follow-up radiograph (Fig. 2B), the splint was removed, and the patient started a gradual physiotherapy program to improve knee ROM and strengthen the muscles around the knee. By the last follow up (at six months), the knee ROM reached 110° of flexion, and the radiographs showed complete healing of the fracture, accepted alignment (aTF angle was 190°, and the aLDFA was 83°), and stable implants (Fig. 2C).

Patient #2

67 years old, her BMI was 33 kg/m², and she has diabetes. She had bilateral knee varus deformity preoperatively, more on the right

side, which had an aTFA of varus 12° (Fig. 3A). We operated on the right knee; intraoperative bony defect of the medial femoral condyle and the medial tibial plateau was encountered, treated by bone autograft (obtained from the bony cuts) and screw augmented by cement, respectively (the femoral component was size D) (Fig. 3B). Immediate postoperative radiographs showed restoration of the anatomical axis of the knee (aTF angle was 188°) and proper positioning of the femoral component where aLDFA was 85° (Fig. 3C).

The patient was lost to follow up; she presented six months postoperatively complaining of mild pain with deformity in the operated knee. She reported experiencing vague pain in her knee with the inability to put weight two weeks postoperatively; she denied any history of trauma, and upon consultation with a local orthopedic surgeon, he informed her that she had a distal femoral PPF and prescribed for her a long leg splint in which she spent two months with no weight-bearing, after which she started gradual physiotherapy to mobilize the knee. Upon clinical examination at the time of presentation, the knee was in valgus deformity, the knee range of motion (ROM) was up to 95° , and the knee was stable. The radiographic evaluation confirmed the valgus deformity (aTF angle was 197° , and the aLDFA was 77° , indicating valgus malposition of the femoral component); femoral and tibial components were stable. A healed lateral femoral condyle fracture was noted in the radiographs (Fig. 3D). The option of revision TKA was discussed with the patient; however, she reported that she is satisfied with the current status and preferred to wait.

Discussion

A femur or tibia fracture within 15 cm of the TKA joint line or 5 cm from a TKA stem extension is considered a PPF [3]. Various risk factors for PPF after primary TKA had been identified, such as female gender, inflammatory arthropathy, osteoporosis, chronic steroid use, elevated BMI, diabetes, anterior femoral notching, and older age [3,4,6].

Diabetes had been considered a risk factor predisposing to PPF, as those patients could have an increased risk of falls; even more, diabetes increases the risk of non-union and infection after managing PPF by open reduction and internal fixation [11]. Hoffmann et al. reported that out of 36 patients diagnosed with PPF after primary TKA, 35 had a mean BMI of 32.4, indicating a possible relationship between high BMI and increased risk of PPF [6]. Furthermore, according to Singh et al. and Meek et al., female patients below 60 and above 80 were significantly at higher risk of PPF [4,12].

Management options vary greatly and depend on many variables, including the patient's general status, functional needs, bone quality, site of the fracture, and type of TKA prosthesis used [3]. Others suggested that the surgeon's efficiency and the accompanying

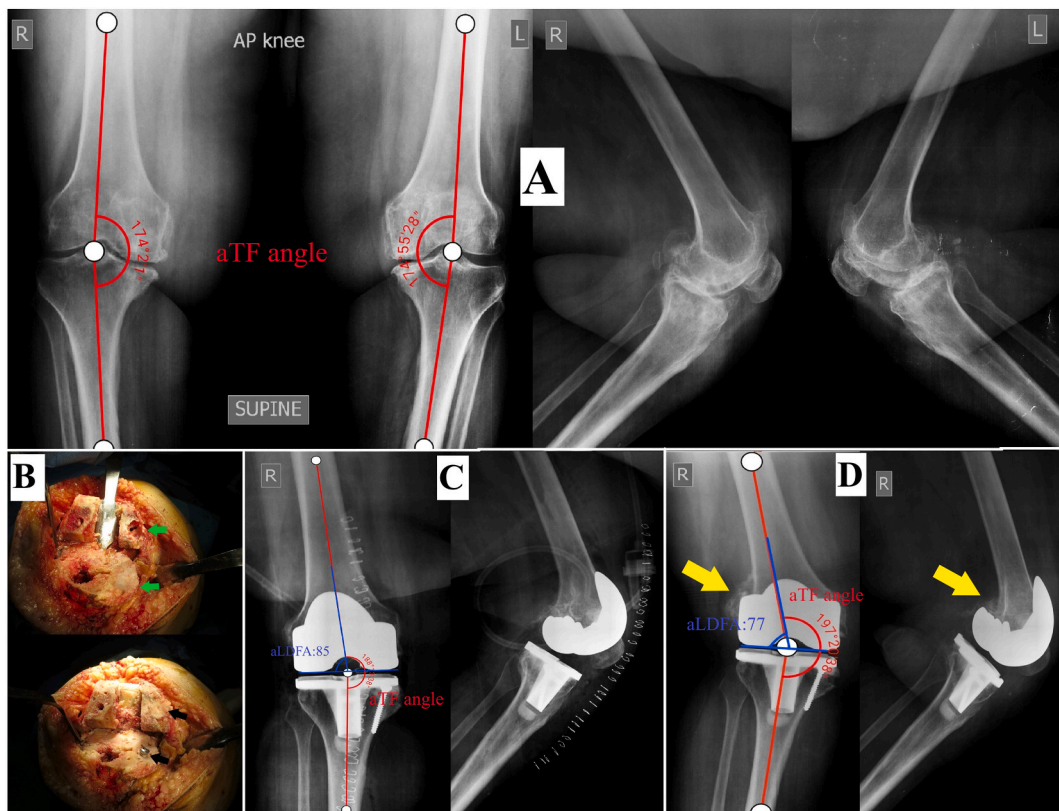


Fig. 3. Patient #2. A, Preoperative anteroposterior and lateral views of her knees bilaterally. B, An intraoperative image shows the bony defect in the medial femoral condyle and the medial tibial plateau (green arrowheads) and reconstruction using bone graft and screw (black arrowhead). C, Immediate postoperative of the right knee TKA showing accepted limb and femoral component alignment. D, Follow up at six months showing a valgus alignment of the limb and the femoral component with a healed lateral distal femoral condyle fracture (yellow arrowhead).

surgical team are equally important [11]. In our situation, we believe that the financial and economic status should be considered.

PPF could be treated nonsurgically (for non-displaced fractures and if the patient's condition could not allow further surgery) with acceptable outcomes [9], or surgically which could be ORIF (using plate and screws or intramedullary nails) or revision TKA (isolated femoral component revision and both components revision either using stemmed constrained implants or distal femoral replacement (tumor megaprosthesis)) [1,6–8,11,13].

What raises queries about the two cases we present is that in one patient, we operated on both knees; however, the insufficiency fracture occurred in one knee. In the other patient, although the weaker side was the medial femoral condyle (which had a bony defect) with an apparent intact lateral femoral condyle intraoperatively, however, the fracture occurred in the lateral femoral condyle. Furthermore, we recently received another female patient three weeks postoperatively after having a PS TKA (Scorpio NRG, PS, Stryker Orthopedics, Mahwah, New Jersey, USA) with a complete dissolving of the distal femur with no history of trauma (we could not include her in the report as we could not obtain a complete record, Fig. 4).

Carli et al. reported two sisters who underwent primary TKA on the same day with nearly identical surgical circumstances (same surgeon, implants, operative room, and same surgical team). Both presented by distal femoral PPF two weeks postoperatively, where they were treated by revision TKA; the authors reported that the histopathological examination of the bone biopsy obtained from the distal femur during revision showed osteoporosis and bone ischemia; they recommended adding a stem to the femoral component if the surgeon encounter distal femoral deficient bone stock [7].

Vestermark et al. reported on seven patients who presented with distal femoral PPF following primary TKA after a mean of 24.9 days, six were females, and the mean BMI was 29.4. The authors reported having a fracture of the unloaded femoral condyles in all patients; five valgus deformities had a fracture of the medial femoral condyle and vice versa; in six patients, the authors waited for six weeks to perform femoral component revision to allow time for the fracture to heal in order to preserve bone stock, to be noted that the authors used stemmed femoral components and augments for revision [1]. On the other hand, Jassim et al. reported on 11 female patients who presented with distal femoral PPF where all were treated with distal femoral replacement revision implants with acceptable functional and radiological outcomes [13].

Some previous reports offered several explanations for the occurrence of such early insufficiency fractures:

First, the idea of a weak unloaded condyle (lateral femoral condyle in case of varus knee and vice versa) combined with osteoporosis or osteopenia could act as a risk for these fractures development, especially after increased loads postoperatively [1,8]. Some authors suggested preoperative investigation and optimization of osteomalacia and osteoporosis to guard against insufficiency fractures [7,14]. However, the data in this regard are still inconclusive.

Second, using PS implants, which entails the removal of a bony block from the femur to adapt to the femoral component box, has been proposed as a risk factor for distal femoral weakness, especially in females with relatively small distal femoral geometry [1,7,15]. However, in the study by Shahi et al., the authors reported that 15 patients presented with distal femoral insufficiency fractures (11 were atraumatic), although the implant used was cruciate-retaining, which does not necessitates bony block removal from the central femur to adapt the box [8].

Third, the possible thermal-induced osteonecrosis while cement is curing after prosthesis implantation, Whitehouse et al. showed a negative effect of bone cement on osteocytes viability in patients undergoing cemented total hip arthroplasty, which could affect the bone cement interface and affect the underlying bone quality [16].

The dilemma exists in defining which patient is susceptible to such distal femoral insufficiency fracture and whether a stem should be added to the femoral component during the primary surgery. Some authors recommended adding a stem to the tibial component when the surgeon encounters an obese patient, especially females with osteoporotic bone, to guard against early tibial failure [17]. However, this is different for the femoral component as most designs will need a revision system femoral component that accepts a stem extension, which could increase the cost and further jeopardize the distal femoral bone stock by cutting a larger box [7].

We believe that the nonsurgical line as performed in the current report could be an option for some reasons; first, we achieved acceptable outcomes (still to be proved as it needs a longer follow up) with a considerable economic solution, as it helped us avoid

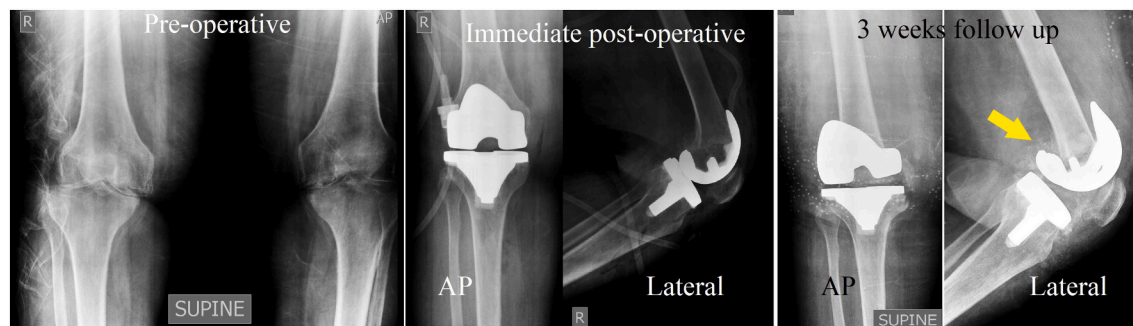


Fig. 4. Female patient, 71 years old, presented after 3 weeks of having right TKA with atraumatic distal femoral fracture (yellow arrowhead) and loose femoral component (a demonstrative case, not included in the report).

revision surgery (which in our country could cost the healthcare system or the patient double the cost of the primary surgery). Second, this could be an initial step (till the fracture heals) in preparation for future revision surgery, as suggested by Vestermark et al., as early revision could lead to massive iatrogenic bone loss. Third, this option could give the patient some time for antiresorptive management to restore bone stock.

Conclusions

Early insufficiency distal femoral fracture post-primary total knee arthroplasty could be challenging to manage. A conservative management line is an economical option with an acceptable early result. Furthermore, it could help preserve bone stock if a future revision was decided.

Study setting

Assiut University Hospital, Assiut, Egypt.

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Ethics approval and consent to participate

Ethical approval for this case report was not needed as this was considered a part of the usual patients' care.

Consent for publication

A verbal, as well as informed written consent, was obtained from patients to use their clinical data and images for publication of this case report; no identification of the patients' identity is present neither in the manuscript nor in the images.

CRedit authorship contribution statement

AMA carried out the case report conception and performed the surgery; AAK carried out data acquisition, measurements, and literature search. Both authors drafted the manuscript and designed the figures. AMA did the critical revision. Both authors read and approved the final manuscript.

Conflict of interest

No conflict of interest for any author concerning this manuscript.

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References

- [1] G.L. Vestermark, S.M. Odum, B.D. Springer, Early femoral condyle insufficiency fractures after total knee arthroplasty: treatment with delayed surgery and femoral component revision, *Arthroplast Today* 4 (2018) 249–253.
- [2] D.J. Berry, Epidemiology: hip and knee, *Orthop. Clin. North Am.* 30 (1999) 183–190.
- [3] G. Canton, C. Ratti, R. Fattori, B. Hoxhaj, L. Murena, Periprosthetic knee fractures. A review of epidemiology, risk factors, diagnosis, management and outcome, *Acta Biomed* 88 (2017) 118–128.
- [4] J.A. Singh, M. Jensen, D. Lewallen, Predictors of periprosthetic fracture after total knee replacement: an analysis of 21,723 cases, *Acta Orthop.* 84 (2013) 170–177.
- [5] V. Gondalia, D.H. Choi, S.C. Lee, C.H. Nam, B.H. Hwang, H.S. Ahn, et al., Periprosthetic supracondylar femoral fractures following total knee arthroplasty: clinical comparison and related complications of the femur plate system and retrograde-inserted supracondylar nail, *J. Orthop. Traumatol.* 15 (2014) 201–207.
- [6] M.F. Hoffmann, C.B. Jones, D.L. Sietsema, S.J. Koenig, P. Tornetta 3rd., Outcome of periprosthetic distal femoral fractures following knee arthroplasty, *Injury* 43 (2012) 1084–1089.
- [7] A.V. Carli, I. Gkiatas, T.W. Bauer, T.M. Wright, F.Q. Gonzalez, P.K. Sculco, Sister, Sister! Siblings with simultaneous early femoral insufficiency fractures after Total knee arthroplasty, *Arthroplast Today* 7 (2021) 188–193.
- [8] A. Shahi, U.H. Saleh, T.L. Tan, M. Elfekky, S. Tarabichi, A unique pattern of peri-prosthetic fracture following Total knee arthroplasty: the insufficiency fracture, *J. Arthroplast.* 30 (2015) 1054–1057.
- [9] W.M. Ricci, Periprosthetic femur fractures, *J. Orthop. Trauma* 29 (2015) 130–137.
- [10] A.A. Khalifa, A.B. Mullaji, A.M. Mostafa, O.A. Farouk, A protocol to systematic radiographic assessment of primary total knee arthroplasty, *Orthop. Res. Rev.* 13 (2021) 95–106.
- [11] W.M. Ricci, T. Loftus, C. Cox, J. Borrelli, Locked plates combined with minimally invasive insertion technique for the treatment of periprosthetic supracondylar femur fractures above a total knee arthroplasty, *J. Orthop. Trauma* 20 (2006) 190–196.
- [12] R.M. Meek, T. Norwood, R. Smith, I.J. Brenkel, C.R. Howie, The risk of peri-prosthetic fracture after primary and revision total hip and knee replacement, *J. Bone Joint Surg. Br.* 93 (2011) 96–101.

- [13] S.S. Jassim, I. McNamara, P. Hoggood, Distal femoral replacement in periprosthetic fracture around total knee arthroplasty, *Injury* 45 (2014) 550–553.
- [14] J.T. Bernatz, A.E. Brooks, M.W. Squire, R.I. Illgen 2nd, N.C. Binkley, P.A. Anderson, Osteoporosis is common and undertreated prior to total joint arthroplasty, *J. Arthroplast.* 34 (2019) 1347–1353.
- [15] M.K. Abdelnasser, A.A. Khalifa, M. Bassem, M.A. Abdelhameed, M.F. Adam, H.M. Bakr, et al., Anthropometric measurements of non-arthritic knees in an Egyptian population: an MRI-based study, *J. Orthop. Surg. Res.* 16 (2021) 552.
- [16] M.R. Whitehouse, N.S. Atwal, M. Pabbruwe, A.W. Blom, G.C. Bannister, Osteonecrosis with the use of polymethylmethacrylate cement for hip replacement: thermal-induced damage evidenced in vivo by decreased osteocyte viability, *Eur. Cell Mater.* 27 (2014) 50–62, discussion-3.
- [17] B.J. Schultz, M.R. DeBaun, J.I. Huddleston 3rd., The use of stems for morbid obesity in total knee arthroplasty, *J. Knee Surg.* 32 (2019) 607–610.