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Medial Tibial Plateau Stress Fracture Following Navigated Total Knee Arthroplasty: Two Case Reports

Authors' Contribution:

Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

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Case series

Patients: Female, 47-year-old • Female, 58-year-old
Final Diagnosis: Periprosthetic fracture
Symptoms: Medial knee pain • varus deformity
Medication: —
Clinical Procedure: —
Specialty: Orthopedics and Traumatology

Objective: Diagnostic/therapeutic accidents

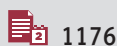
Background: Computer navigation in total knee arthroplasty has been gaining worldwide interest among orthopedic surgeons. While there is controversial data regarding its potential better clinical outcomes compared to conventional total knee arthroplasty, it has been shown to improve component and limb alignment reliability at a potential cost of increased complications. We present 2 case reports of medial tibial stress fracture through navigated tibial cutting block pinhole sites.

Case Reports: Both cases involved morbidly obese patients who underwent a navigated total knee arthroplasty. During surgery, there were no intraoperative concerns. Both knees were well aligned postoperatively and no unusual pain was reported. At 6 months after total knee arthroplasty, a periprosthetic fracture was initiated at a cutting block pinhole site with varus collapse of the tibial component. In both cases, the pinhole site was close to the medial tibial cortex and the primary tibial component collapsed into the varus, requiring revision to a stemmed component with allograft bone. For both patients, the revision arthroplasty continues to perform well. We believe cutting block design in combination with small tibias and elevated body mass index contributed to this complication.

Conclusions: Robotic-assisted total knee replacement has been shown to improve precision in component alignment. We caution against placing cutting block pinholes close to the medial tibial cortex, especially in morbidly obese patients with small tibias.

Keywords: Arthroplasty • Fractures, Stress • Knee

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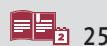
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Background

Navigated total knee arthroplasty (TKA) was first introduced in the late 1990's. Improvements in component alignment following navigated TKA as compared to conventional TKA have been reported [1-4] and navigation has been shown to reliably assess component and limb alignment intraoperatively during TKA [1,5,6]. This alignment reliability comes with the disadvantages of an increased operation time and possibly increased complication rate [4,7,8]. The incidence rate of periprosthetic fractures through tracking pin sites is 0.06% to 4.8% [1]. However, limited data exist in the current literature from case reports and case series on pin-related fractures [1].

We present 2 cases of medial tibial stress fracture through navigated tibial cutting block pinhole sites. Both patients had a primary TKA implanted with the aid of navigational component alignment and ligamentous balancing. As part of the routine operative technique, a medial 4-mm unicortical anchoring pin was used to secure the tibial jig in place. Both patients required revision knee arthroplasty. The treating surgeons had extensive experience with the navigation system and implants used for these 2 cases and were the operating surgeons for the primary and then revision surgery for each case.

Case Reports

Case 1

A 47-year-old morbidly obese woman (body mass index, BMI: 51.4 kg/m²) underwent a navigated cruciate retaining cemented

left total knee replacement for varus osteoarthritis (Figure 1A). There was no immediate evidence of intraoperative complications. A size 3 femoral component, size 2 tibial base plate, a 27-mm inset patella, and an 11-mm polyethylene tibial insert were implanted. Postoperative coronal alignment was 0.5 degrees valgus (Figure 1B). Early postoperative recovery was uneventful. At follow-up 6 weeks postoperatively, she had significantly improved mobility and knee range of motion, but described medial pain. Review of her X-rays demonstrated a periprosthetic fracture initiated at a cutting block pinhole site with varus collapse of the tibial component (Figure 1C). She was revised to stemmed tibial and femoral components with totally stabilized constraint, structural and morcellized allograft bone to the proximal tibia, and a lateral retinacular release (Figure 1D). At 12 months, the revision arthroplasty continues to perform well.

Case 2

A 58-year-old obese woman (BMI: 31.8 kg/m²) underwent a navigated posteriorly stabilized reverse hybrid left total knee replacement for valgus inflammatory arthritis (Figure 2A). As part of an ongoing radiostereometric analysis study, she was randomized to receive an uncemented tibial component. There was no immediate evidence of intraoperative complications. A size 2 cemented femoral component, size 3 uncemented Peri-Apatite™ tibial base plate, a cemented 29-mm inset patella, and an 11-mm polyethylene tibial insert were implanted. Postoperative coronal alignment was 1 degree varus (Figure 2B). Early postoperative recovery was uneventful. At follow-up 1 year postoperatively, she reported having medial knee pain and had increasing varus deformity. Serial X-rays demonstrated gradual collapse of her tibial component into

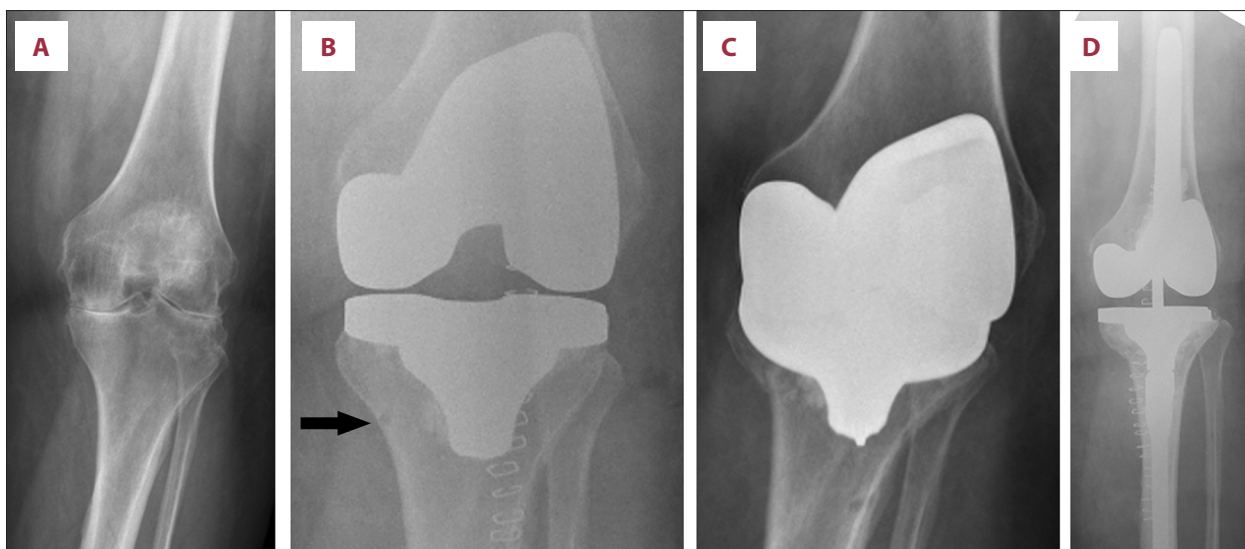


Figure 1. Case 1 X-rays. (A) Pre-op, (B) Immediately postoperatively. The cutting block pinhole is clearly seen adjacent to the medial tibial cortex (arrow). (C) Six weeks postoperatively, with fracture through the pinhole and collapse into varus. (D) Postoperative revision.

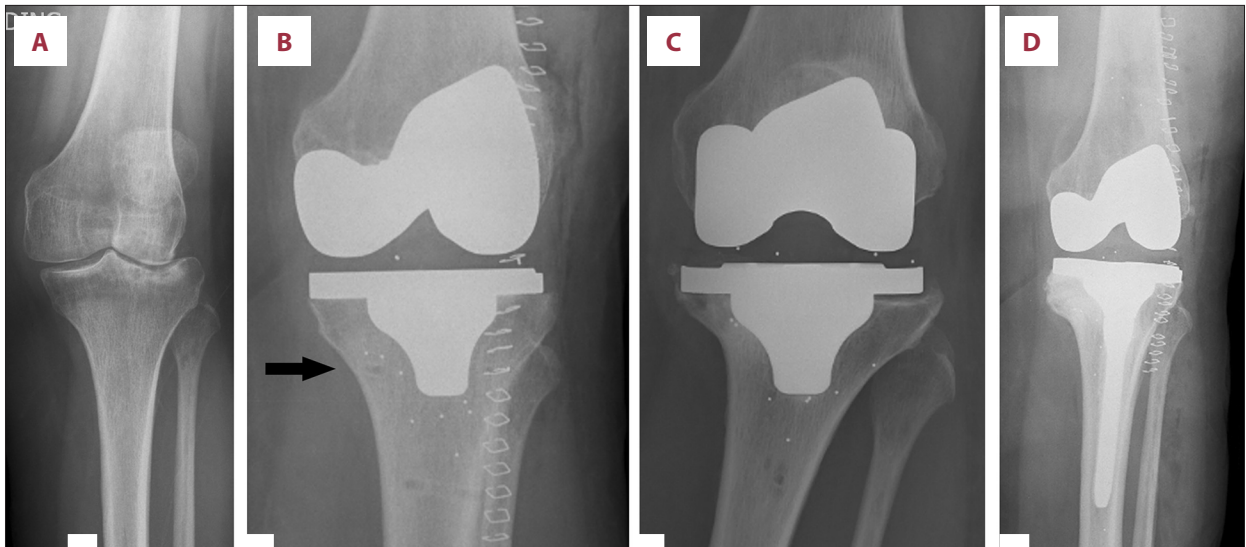


Figure 2. Case 2 X-rays. (A) Pre-op, (B) Immediately postoperatively, with cutting block pinhole adjacent to the medial tibial cortex (arrow), (C) One year postoperatively, with varus angulation at the level of the medial pinhole. (D) Postoperative revision.

the varus, with angulation of the medial cortex at the site of the cutting block pinhole (Figure 2C). Infection was excluded by normal C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and knee aspirate. At 1 year after total knee replacement, she underwent revision surgery to a posteriorly stabilized stemmed tibial component and morcellized allograft to the proximal medial tibia (Figure 2D). At 3 months, the revision arthroplasty continues to perform well.

Discussion

Periprosthetic tibial fractures after TKA have been attributed to technical surgical details and to predisposing host or patient risk factors. Patient risk factors include osteoporosis, morbid obesity, female gender, advanced age, and neurologic disorders [9-11]. Comorbid conditions like chronic renal disease, corticosteroid use, and rheumatoid arthritis may result in abnormal bone remodeling, which can delay the resolution of iatrogenic cortical defects created during navigated pin placement [9]. Surgical details that have been attributed to postoperative periprosthetic fractures include improper component position, varus malalignment, and revision TKA considerations. Component loosening may also be a risk [12-15]. Navigation tracker pins have previously been implicated in tibial and femoral fractures following computer-assisted TKA [1,9,16-21]. Stress concentration near pinhole sites has been documented to increase fracture risk [22] and the pins used to secure the tibial cutting jig in unicompartmental knee arthroplasty have been reported to predispose to tibial plateau stress fracture [23-25]. Here, we report 2 cases of tibial plateau stress fracture as a complication of tibial cutting block pin placement in computer-navigated TKA.

The fractures were not noted intraoperatively or detected on initial postoperative X-rays. Both patients were allowed to bear weight as tolerated postoperatively with routine physiotherapy input. No unusual pain was reported. There was no history of stiffness or trauma. Both knees were well aligned postoperatively. Neither patient had been diagnosed with osteoporosis. Repetitive loading was considered to have resulted in stress fractures through the medial tibial cortex, which had been compromised by the placement of the tibial cutting block pins. Both patients were obese and increased BMI may have contributed. Interestingly, the first patient had sustained a fracture by 6 weeks postoperatively, while the second performed well for almost 1 year before reporting medial-sided knee pain. It is possible that the fixation of the tibial component (cemented in the first case and uncemented Peri-Apatite™-coated in the second case) played a role in this difference.

We believe the design of the navigation tibial cutting block in combination with smaller tibias is an important contributing factor. The pin sites for the navigation cutting block are more distal than the corresponding non-navigation block, placing the holes further down the medial flare of the tibia and therefore closer to its medial border. Furthermore, as tibial size decreases, the medial cutting block hole becomes closer to the medial cortex of the tibia. We feel this combination placed the medial pinhole too close to the medial tibial cortex. Biomechanical studies are required to further quantify this problem.

The cause of fracture complication identified in this report has directed us to select a more proximal medial hole on the navigation tibial cutting block when small tibial size is anticipated and to use a short-cemented stem to bypass the stress riser caused by a pinhole that is noticed at the time of surgery to

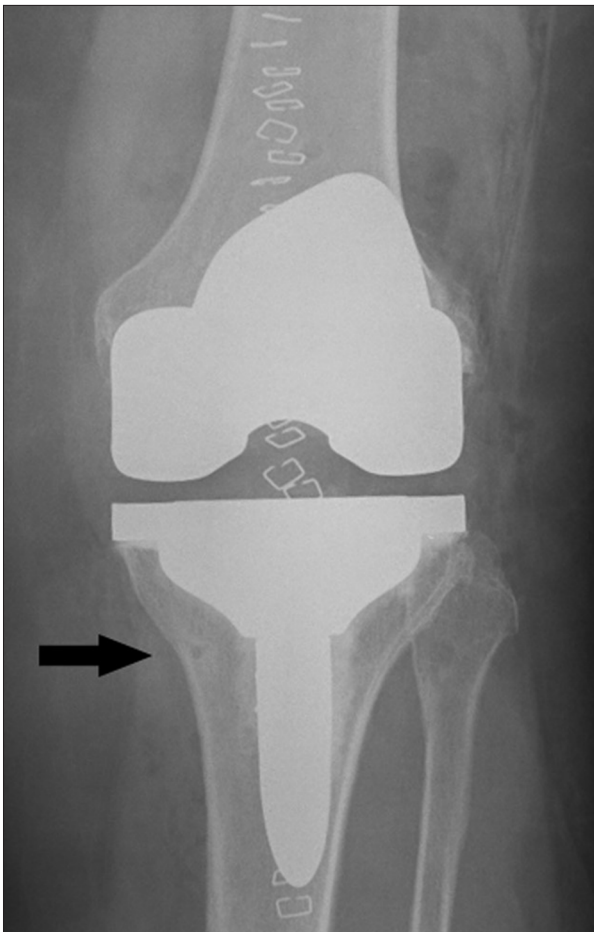


Figure 3. At-risk tibia identified intraoperatively and managed with prophylactic cemented stem.

be too medial (**Figure 3**). Placing the medial hole more proximally through the block to avoid medial pin placement, however, does not allow the cutting block to be easily repositioned more distally if the tibia needs to be recut. Navigation tibial cutting block design changes would make recutting the tibia easier and would have the potential to prevent users of the system from creating the medial pinhole stress risers.

Conclusions

Robotic-assisted total knee replacement has been shown to improve precision in component alignment. Due to the position of the medial pinhole sites in some of the robotic knee-cutting block designs, we recommend caution in utilizing those pin hole sites that may predispose patients to periprosthetic fractures, especially in morbidly obese patients with small tibias.

Department and Institution Where Work Was Done

Division of Orthopaedic Surgery, Dalhousie University.

Conflicts of Interest

None.

Declaration of Figures Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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