This article appeared in a journal published by Elsevier. The attached copy is furnished to the author for internal non-commercial research and education use, including for instruction at the authors institution and sharing with colleagues.

Other uses, including reproduction and distribution, or selling or licensing copies, or posting to personal, institutional or third party websites are prohibited.

In most cases authors are permitted to post their version of the article (e.g. in Word or Tex form) to their personal website or institutional repository. Authors requiring further information regarding Elsevier’s archiving and manuscript policies are encouraged to visit:

http://www.elsevier.com/authorsrights
Fatigue fracture of tibial arthroplasty implant masked by contralateral knee arthritis

Barry J. O’Neill *, May Cleary, John P. McElwain

Department of Orthopaedic Surgery, The Adelaide & Meath Hospital Incorporating the National Children’s Hospital, Tallaght, Dublin 24, Ireland

ARTICLE INFO

Article history:
Received 16 November 2012
Received in revised form 1 February 2013
Accepted 25 February 2013
Available online xxx

Keywords:
Arthroplasty
Complications

ABSTRACT

INTRODUCTION: The wear of polyethylene components is a well-recognised long-term complication of total knee arthroplasty. 
PRESENTATION OF CASE: We present a case of fatigue fracture of a geomedic tibial tray 17 years after implantation. The symptoms were masked by primary osteoarthritis of the contralateral knee.
DISCUSSION: The mode of failure in this case differs from that most commonly reported in the literature in that it occurred late as the result of prolonged use, not due to implant failure, physiological factors, or surgical technique. The case also demonstrates the incredible ‘masking’ effect of arthritic knee pain.
CONCLUSION: This case highlights the importance to clinicians of keeping a high index of suspicion for prosthesis complications in patients with unilateral joint replacement with contralateral arthropathy.

1. Introduction

The wear of polyethylene components is a well-recognised long-term complication of total knee arthroplasty.1 Fracture of hip prostheses is well documented,2–6 and fracture of knee arthroplasty components is also reported.7–14 We report a case of late tibial tray fatigue fracture with bony impaction where the symptoms were masked by contra-lateral primary knee osteoarthritis. We hypothesise that the wear of the polyethylene liner was biased towards the medial plateau, mimicking the varus deformity seen in osteoarthritis with chondral wear. This unequal loading of the tibial implant contributed to its failure.

2. Case report

A 49-year-old man underwent left total knee arthroplasty at our institution in February 1990. A standard midline incision with medial para-patellar approach was used to implant a Geomedic Total Knee prosthesis (Howmedica). The procedure and post-operative rehabilitation were uneventful and he was followed-up routinely. In September 2007 the patient re-attended our outpatient department (OPD) complaining of severe contra-lateral right knee pain. This pain had started three years previously and had been gradually increasing in severity. At time of presentation he reported a walking distance of 500 yards and regular sleep disturbance. He reported a pain-free left knee and examination demonstrated a range of motion of 0°–110°. Radiographs of both knees showed primary osteoarthritis of the right knee, and apparent distortion of the tibial component of the left knee prosthesis, with metallic debris in the posterior soft tissues (Fig. 1).

He was admitted to our institution in January 2008 and underwent right total knee arthroplasty. Prior to this procedure he remained pain-free in the left knee, but post-operative rehabilitation of the right knee arthroplasty was limited by severe pain in the left knee. His weight was recorded as 90 kg and height at 1.74 m (BMI = 30). Examination of the left knee revealed gross crepitus throughout the range of motion, with increased varus-valgus laxity. Radiographs demonstrated further distortion of the tibial component of the left knee with obvious fracture of the prosthesis.

In November 2008 this man was admitted for revision arthroplasty of his left knee. Pre-operative radiographs showed further damage to the medial aspect of the tibial tray (Fig. 2). His knee was approached through a midline incision and medial para-patellar arthrotomy. The polyethylene spacer was eroded down to metal with only the central spine remaining attached to the tibial tray. The medial aspect of the tibial tray was fragmented with a large sagittal fracture through the table and a coronal fracture through the posterior condyle with comminution (Fig. 3).

On extraction of the fragments the medial aspect of the tibia showed cavitation of the cancellous bone under the medial weight-bearing surface. All metal and debris were removed and a revision prosthesis was implanted. This implant incorporated modular stemmed components in the femur and the tibia. Medial and lateral augments were incorporated into the tibial component to address the bony deficiency caused by the subsidence of the primary implant. The post-operative period was unremarkable and the patient was discharged home to continue his rehabilitation. He was reviewed regularly for the first twelve months.
This case demonstrates the incredible ‘masking’ effect of arthritic knee pain. This patient maintained good pain-free function in his left knee despite catastrophic failure of the tibial load-bearing implant. The extent of this ‘masking’ effect was only revealed when the pain from the contralateral arthritic knee was addressed. Bartel et al.\textsuperscript{11} demonstrated that the major fraction of the total load on a tibial component is transmitted across the plateau, not the peg. Scott et al.\textsuperscript{12} theorised that the rigid central stem of the tibial prosthesis may lead to reduced stresses on the tibial plateau resulting in resorption of the bone endplate and implant fracture. Ranawat et al.\textsuperscript{13} examined a fractured porous coated cementless tibial tray and found the fracture surfaces extensively burnished, consistent with the fracture surfaces persistently rubbing against each other for a prolonged period of time. The loosened portion of the tray may act as a cantilever, resulting in increased stresses between the rigid and loose portions of the prosthesis.

Analysis of the tibial tray in the case described here showed a fatigue fracture at the narrowest ante-ro-posterior diameter of the prosthesis. This area corresponds to the corner between the middle ‘bridge’ and the medial weight-bearing surface of the tray. Morrey and Chao\textsuperscript{14} also discussed stress distribution as a cause for tibial tray fracture. They also implicated increased functional demands in younger and heavier patients, and reported on a case where deficient tibial plateau bone stock resulted in early varus mal-alignment of the component with subsidence of the medial tibial plateau causing implant fracture.

In the reported case it is difficult to say with certainty what factors initiated failure. At 49 years he was relatively young at the time of arthroplasty. His physical demands could only be described as moderate, although his BMI was 30 at the time of implant failure. Kerkhoffs et al.\textsuperscript{15} have shown that a BMI of greater than or equal to 30 is associated with a higher incidence of revision after total knee arthroplasty, whereas a BMI of less than 30 is not. This patient had a BMI of 30 at time of presentation, but we have no accurate record of his BMI prior to failure of his implant. We theorise that as his right knee pain increased in severity his activity level decreased, with a subsequent rise in his BMI and further loading of his tibial implant, ultimately leading to failure of the implant.
The mineral density of trabecular bone is associated with the quality of the bone and this is considered to be an important predictor of failure in total knee arthroplasty. Periprosthetic bone density can be demineralised by up to 22% in the proximal tibia after total knee arthroplasty, whilst the bone density in the contralateral knee remains unchanged. Despite this, a relationship between postoperative densitometric changes after total knee arthroplasty and implant failure has not been established. Counter-intuitively, a high preoperative bone mineral content in the proximal tibia has been associated with later revision surgery. The patient in the case presented has never had bone density assessment. There was nothing in his history to suggest that he should have a low bone mineral density (BMD) at the time of his index left knee surgery, so it could be assumed that his BMD at this time was normal. Should his BMD have been high at the time of his index procedure, could this have contributed to his subsequent implant failure? In the absence of bone densitometry, any answer is speculative.

In this case, the prosthesis lasted for 17 years before the fracture was detected. The patient had not attended our OPD for ten years prior to detection of the fracture, and as such had no radiographic imaging of his left knee performed between 1997 and 2007. It is apparent from reviewing the patient’s history that the pain of the fractured implant was ‘masked’ by the pain from the contralateral arthritic knee. The pain he suffered in his right knee had been increasing in severity over a three year period. This would suggest that the fracture of the tibial prosthesis had occurred during this three year period. This ‘masking’ phenomenon prevented early diagnosis and intervention, and resulted in further varus loading and impaction of the cancellous bone under the broken part of the tibial tray.

We hypothesise that the wear of the polyethylene liner was biased towards the medial plateau, mimicking the varus deformity seen in osteoarthritis with chondral wear. This abnormal loading of the tibial tray altered the mechanical axis of the knee, resulting in abnormal loading of the medial tibial component, increasing the stresses across the junction between the medial plateau and the narrow inter-chondylar bridge. When fracture occurred the stresses were then transferred to the medial bone endplate which subsided significantly. This subsidence required augmentation with bone cement and a 10 mm augmentation device on the underside of the revision tray.

Although tibial tray fracture is well reported in the literature, it is generally found to be an early complication secondary to implant impurities, poor surgical technique, or poor bone quality. We describe a case of implant failure after 17 years, where the mode of failure seems to mimic the mode of failure of the biological knee in osteoarthritis, and where the diagnosis was masked by primary osteoarthritis of the contralateral knee.

4. Conclusion

This case highlights the importance to clinicians of keeping a high index of suspicion for prosthesis complications in patients with unilateral joint replacement with contralateral arthropathy. It also highlights the benefits of long-term clinical and radiographic review of arthroplasty patients to enable early detection and prevention of late complications.

5. Conflict of interest

None.

6. Funding

None.

7. Consent

The patient referred to in this case report has given signed written consent for the case to be published.

8. Author contributions

Barry J. O’Neill wrote the manuscript. May Cleary revised the manuscript and took the clinical photographs. John P. McElwain is the senior surgeon responsible for the case and the overall care of the patient.

References


Open Access
This article is published Open Access at sciencedirect.com. It is distributed under the IJSCR Supplemental terms and conditions, which permits unrestricted non commercial use, distribution, and reproduction in any medium, provided the original authors and source are credited.