

ARTHROPLASTY

Fatigue failure of the femoral component of a total knee arthroplasty: a case report and review of the literature

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Abstract

Introduction: Reports of fatigue failure of the femoral component of a total knee arthroplasty (TKA) is scanty in the literature. As a result, there are no clearly defined risk factors to aid us in predicting fatigue failure of an implant. Furthermore, these patients may present with non-specific knee pain, which may or may not be well tolerated, depending on the stability of the implant. We report a case of fatigue failure of a poorly cemented femoral component of a TKA in a 72-year-old female, approximately seven years after the initial surgery.

Case report: A 72-year-old female presented to our tertiary level arthroplasty unit with new-onset knee pain approximately seven years after undergoing a TKA at our unit. She reported hearing a crack six months earlier, while standing up from a seated position. She had initially presented to her local clinic, but the pathology was missed. She received revision surgery at our institution and was doing well at early follow-up.

Discussion: We reviewed the literature on fatigue failure of femoral components in TKA in an attempt to define risk factors. We also summarised all cases of femoral component fatigue failure in the English literature.

Conclusion: Although femoral component fatigue failure in TKA is rare, the majority of cases have attributed the failure to poor surgical technique. Despite this, certain implants have been failing more often than others, and proposed mechanisms for this exist. Orthopaedic surgeons need to be aware of which implant designs are prone to failure, as well as how meticulous surgical technique can reduce the chances of fatigue failure.

Level of evidence: Level 5

Keywords: femoral component, total knee arthroplasty, fatigue failure, stress fracture

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Introduction

Reports of fatigue failure of the femoral component of a total knee arthroplasty (TKA) are rare in the literature. While there are some instances where an implant may have an inherent or manufacturing defect, the majority of cases are due to poor surgical technique, resulting in a lack of bony incorporation. As with most implants in orthopaedics, the TKA components are intended to lie on a stable base, be it cement, bone or an augment. Failure in this regard causes the implant to be loaded unevenly, resulting in fatigue failure. Patients with a broken TKA component may present in a multitude of different ways. The presentation usually depends on the amount of implant that is still fixed to bone. Patients with a well-fixed implant, in which only a small portion of the implant has broken off, may still be able to mobilise on the prosthesis, albeit with pain. If the fractured component ends up between the tibial tray and femoral component, the patient may present with locking of the joint.

Case report

Initial surgery

Our case is that of a 72-year-old female who presented with a painful knee approximately seven years after she underwent a TKA for tri-compartmental osteoarthritis. Her index total knee replacement was performed on 15 October 2011. The surgery was performed via a medial parapatellar approach. A size 3 cemented LCS femoral component (Johnson & Johnson DePuy, Raynham, MA, USA) was used, while the tibial implant was a cemented size 3 RP LCS tibial implant with a 10 mm rotating platform polyethylene insert. According to the patient, she did not experience any early post-operative complications. She mobilised well with crutches initially, progressing to full weight-bearing without any walking aids by six weeks.

Presentation

The patient presented to our clinic with a history of knee pain and inability to weight bear. The pain started after she stood up from

a seated position and heard a cracking sound six months prior to her visit to our clinic. This was followed by acute pain and swelling. She reported presenting to her local clinic, but no pathology was noted and she was treated conservatively with analgesia. Due to the chronicity and progressive pain, she decided to come to our institution for a second opinion. She initially presented to the emergency department and was referred to our clinic after the diagnosis of a femoral component fracture was made. Besides being a well-controlled hypertensive, having an increased body mass index and osteoarthritis, she reported no other chronic medical conditions. Her weight and height respectively were 94 kg and 1.6 m, giving her a BMI of 36.72 kg/m².

At presentation to our institution she was unable to mobilise without a walking frame due to pain and instability. Her anterior knee incision was healed with a mature scar. She had a partially correctable 20° varus deformity. Her affected knee was swollen with marked medial-sided joint tenderness. She had an extension and flexion lag. Her range of movement was 0°–5°–90° according to the neutral zero method. Tibial and peroneal nerve function, as well as perfusion at the ankle, was intact. Her pre-operative radiographs revealed a fractured femoral component with signs



Figure 1. X-rays on arrival showing a broken femoral component and loosening of both components



Figure 2. Broken femoral component noted at operation

of loosening of both the femoral and tibial components (*Figure 1*). Laboratory investigations were normal. White cell count (WCC) was $7.87 \times 10^9/L$; erythrocyte sedimentation rate (ESR) was 12 mm/hr; and a C-reactive protein (CRP) was 5 ml/L. Her American Knee Society Score¹ was 14. She gave consent for a revision TKA.

Revision surgery

Incision was done through the old scar, with a medial parapatellar approach. No clinical signs of infection were observed. Intra-articular fluid was used for an alpha-defensin test, which was negative. The fractured femoral component was visualised, but the broken flange was only visualised after removal of the femoral implant (*Figure 2*). Both femoral and tibial components were found to be loose. Both metal implants were successfully removed without further bone destruction. Examination of the fractured medial posterior flange of the femoral component revealed no cement on the implant surface or on the medial posterior condyle. The lack of cement on the posterior condyle of the femur ruled out the possibility of cement debonding. The rest of the implant was well cemented (*Figure 3*). The polyethylene insert had signs of advanced wear, especially over the medial aspect. A thorough debridement was performed. A revision total knee replacement was performed using both augments and stems. Cultures taken intra-operatively were all negative.

Follow-up

Our patient had no post-operative complications and was discharged once the wound was settled and appropriate level of rehabilitation was achieved with physiotherapy. She was seen 15 days after surgery and had no early wound complications. At the six-week follow-up, she was walking with one crutch and her range of movement was 0°–0°–95°. She was still attending regular physiotherapy. Repeat X-rays revealed no radiological signs of loosening (*Figure 4*).

Discussion

The first reported case of fatigue failure of the femoral component of a TKA was described by Cook in 1991.² The majority of the cases reported in the English literature have occurred in the same implant, namely Ortholoc II (Wright Medical, Memphis, TN, USA). This was attributed to a design flaw where the portion of

the implant which overlies the posterior chamfer cut was too thin, particularly in smaller-sized components. Four different authors described cases of fatigue failure of the Ortholoc II TKA. Whiteside *et al.* documented 32 cases of failure of the femoral component,³ while Wada *et al.* described a further three cases of failure in small-sized components.⁴ Swarts *et al.* presented a further six cases of uncemented femoral implant failures,⁵ while Chun *et al.*⁶ described another two femoral component fractures in cemented implants of the same design. Two femoral component fractures have been reported with the Genesis II (Smith & Nephew, Memphis, TN, USA).^{7,8} In the Genesis II cases, one was cemented and the other was not. Three femoral component fractures were reported with the PFC Implant (Johnson & Johnson DePuy, Raynham, MA, USA). Sarraf *et al.*⁹ published a case of a femoral component fracture in a cemented implant, while Duffy *et al.*¹⁰ reported two cases of fracture in uncemented implants. Park *et al.*¹¹ reported a femoral component fracture in a cemented titanium implant, the B-P™ Total Knee System (Endotec, Orlando, FL). Huang *et al.*¹² reported a case of fracture of the femoral component of a Rotating Platform Low Contact Stress (RP-LCS) prosthesis (Johnson & Johnson DePuy, Raynham, MA, USA), and Lemaire *et al.* reported it in the Meniscus Bearing LCS system¹³ (Johnson & Johnson DePuy, Raynham, MA, USA). Both these femoral implants were uncemented. Han *et al.*¹⁴ reported a similar complication with a cemented Anterior-Posterior Glide Low Contact Stress (AP-Glide LCS) (Johnson & Johnson DePuy, Raynham, MA, USA) prosthesis.

It is theorised that uncemented femoral implants can undergo fatigue failure when there is uneven bony ingrowth or osteolysis, resulting in uneven load transmission through the prosthesis and therefore fatigue failure. In cemented implants, osteolysis has been proposed as a potential cause.^{8,12} The reported cases of cemented implant failures failed at a mean of 81.6 months. This is in keeping with a fatigue fracture occurring late after the initial surgery. In our case, the cause of failure is difficult to establish due to the delayed presentation. We postulate that it is likely due poor cementing technique. The retrieved implant revealed no cement on the broken posterior medial flange which could have contributed to the loosening and subsequent fatigue failure. The omission of cement on the broken posterior medial could have contributed to the aseptic loosening and abnormal load on the metal. Osteolysis may also have caused the failure. Our patient's increased BMI could have contributed to the broken implant, but



Figure 3. Broken femoral component and worn polyethylene insert after removal. Note the lack of cement on the posterior medial flange of the femoral component

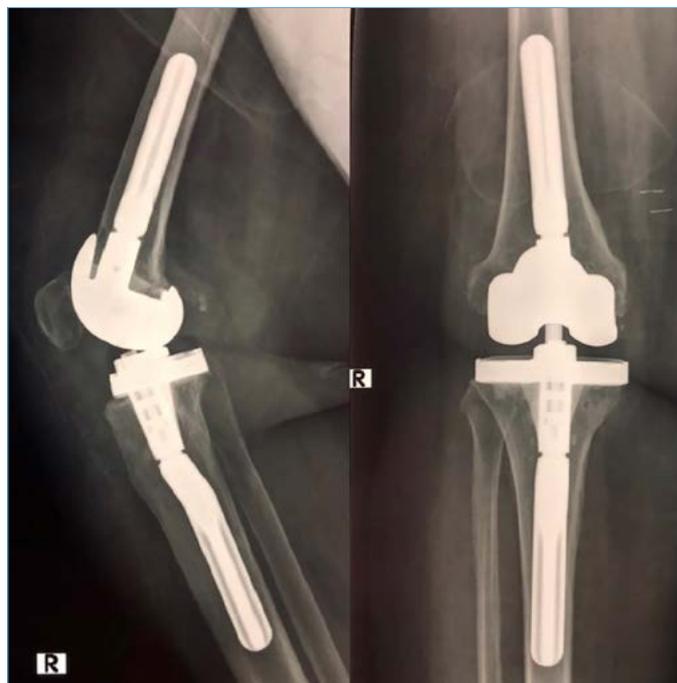


Figure 4. Post-operative X-rays after the revision surgery

Table I: Recorded uncemented femoral component fatigue failure in the English literature (excluding Ortholoc II)

Author and year published	Journal	Implant	Sex	Patient age (years)	Months from surgery to fracture
Michos 2006	<i>Journal of Arthroplasty (JOA)</i>	Genesis II	F	72	36
Duffy 2007	<i>JOA</i>	PFC (press fit condylar)	M	Unknown	Unknown
Duffy 2007	<i>JOA</i>	PFC	M	Unknown	Unknown
Huang 2007	<i>JOA</i>	LCS RP (low contact stress)	M	63	42
Lemaire 2010	<i>Acta Orthopaedica Belgica</i>	LCS men	F	58	78
Saito 2012	<i>Orthopaedics</i>	FNK (flexible Nichidai knee)	F	64	132
Saito 2012	<i>Orthopaedics</i>	FNK	F	64	132

Table II: Recorded cemented femoral component fatigue failure in the English literature (excluding Ortholoc II)

Author and year published	Journal	Implant	Sex	Patient age (years)	Months from surgery to fracture
Luring 2007	<i>The Knee Surgery, Sports Traumatology, Arthroscopy</i>	Genesis II	M	68	108
Sarraf 2014	<i>Bulletin for Hospital for Joint Disease</i>	PFC	M	78	134
Park 2014	<i>Knee</i>	PFC	F	56	36
Han 2009	<i>JOA</i>	APG-LCS (anterior posterior glide-low contact stress)	M	58	43

due to the rarity of the incidence of component fracture compared to the overall trend in obesity in arthroplasty, it is unlikely to be the only risk factor. Vaninbroux *et al.*¹⁵ investigated the optimal cementing technique for the femoral component and concluded that it included cementing of the posterior flanges. Fracture of the femoral component remains rare, but loosening of the component and poor cementing technique can predispose certain implants to fail. Unfortunately, the lack of post-operative X-rays from the initial knee replacement prevents us from drawing any definitive conclusions regarding malposition of the components. Poor implant design, obesity, the use of uncemented femoral components and poor cementing technique appear to increase the risk of implant fatigue fracture.

Conclusion

Femoral component fractures following a TKA are rare. It might be due in part to under-reporting or surgeons opting to revise the implant without adding the complication onto a database or registry. Component fracture should be considered as a potential diagnosis in the total knee replacement patient complaining of acute onset knee pain.

Ethics statement

The authors declare that this submission is in accordance with the principles laid down by the Responsible Research Publication Position Statements as developed at the 2nd World Conference on Research Integrity in Singapore, 2010.

All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Declaration

The authors declare authorship of this article and that they have followed sound scientific research practice. This research is original and does not transgress plagiarism policies.

Author contributions

WG was responsible for study conceptualisation, literature review, first draft preparation and manuscript revision. RG contributed to the study conceptualisation, supervision of the study and assisted in first draft preparation. CF contributed to the study conceptualisation, supervision of the study and assisted in first draft preparation. VS contributed to the study conceptualisation, supervision of the study and assisted in first draft preparation and manuscript revision.

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