

Case Report

A case of revision surgery for loosening in a hinge-type knee arthroplasty with massive tibial bone defect performed approximately 50 years ago

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[Case] A 63-year-old man complained of difficulty walking due to pain from his left knee extending to his lower leg.

[History of present illness] At 15 years old, he suffered a severe open fracture–dislocation of his left knee in a traffic accident. Although the patient had a huge tibial bone defect that was difficult to reconstruct with the era's level of medical knowledge, he chose limb salvage using hinge-type knee arthroplasty, which was unreliable at the time, rather than above-knee amputation. His postoperative course was uneventful, and he was active enough to become a disabled adult golfer. At 62 years old, the patient began to feel unstable in his knees and subsequently had difficulty walking due to pain. Radiographs showed a tibial fracture due to loosening of both femoral and tibial components. After conservative treatment with cast immobilization for two months, revision total knee arthroplasty (TKA) surgery was performed.

[Surgical method] A Shiers hinge-type knee prosthesis had initially been used (1954). After removing the core rod of the hinge portion, both the femoral and tibial components were easily removed. The tibial osteotomy height was determined such that the area of contact with the tibia base was at least two-thirds of the total circumference. The defect in the lateral part of the tibia was reconstructed using the impaction bone graft technique without mesh, assuming that the lateral scar tissue was an induced membrane created by a cement block. A tumor prosthesis was selected because osteotomy would be distal to the medial collateral ligament (MCL) attachment point. As there was no patella, and the only extension mechanism was scar tissue, the patient was immobilized in a cast for four weeks after having patella tendon-like scar tissue fastened to the tibial component with a Fiber Wire®.

[Results] The patient was able to walk independently one month after surgery and resumed golfing six months later. Currently, three years after the surgery, X-rays show grafted bone incorporation with no loosening of the implant. The Knee Society Score (KSS) 2011 improved from 24 points before surgery to 85 points after surgery.

[Conclusion] We experienced an extremely rare case in which a hinge-type knee prosthesis that was implanted approximately 50 years ago was revised due to loosening with a huge bone defect in the tibia, with the details reported.

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Ethical approval and consent to participate

This case report adheres to the ethical principles of the Declaration of Helsinki, ensuring a full explanation of the submission process, obtaining patient consent, and explicitly stating the utmost consideration for patient privacy.

Introduction

Total knee arthroplasty (TKA) is widely performed as a surgical treatment for knee osteoarthritis and rheumatoid arthritis and has achieved excellent pain relief and stable long-term results^{1,2)}. However, since TKA has been mostly performed in middle-aged and elderly people, it is thought that

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there are very few cases that remain highly active and survive 40 to 50 years after surgery.

We herein report a rare case of revision TKA using an impaction bone graft for a massive tibial bone defect in a case of hinge-type knee arthroplasty performed approximately 50 years previously.

Case presentation

The patient was a 63-year-old man whose chief complaint



Fig. 1 Radiographs showed apparent loosening of the femoral and tibial components of the left knee. a) AP view and b) lateral view.



Fig. 2 Tibial X-ray demonstrated an insufficiency fracture due to thinning of the medial cortical bone and callus formation (white arrow).

was difficulty walking due to pain in his left knee and lower legs. At 15 years old, he suffered a severe open dislocation fracture of his left knee in a traffic accident. Because it was a huge tibial defect that was difficult to reconstruct with the era's medical know-how, treatment options were either above-knee amputation or limb salvage using hinge-type knee arthroplasty, which was considered unreliable at the time. The latter was chosen at the patient's request. Although the postoperative course was favorable, follow-up was discontinued only three years after surgery.

There was no pain thereafter, and his lower extremity function was good enough to allow him to become a world-class disabled golfer as an adult. However, at 62 years old, he began to feel unstable in his left knee and subsequently had difficulty walking due to pain in his left knee and lower leg, so he visited our hospital. At the first visit, radiographs showed apparent loosening of both the femoral and tibial components of the left knee (Fig. 1a, b) along with an insufficiency fracture due to thinning of the medial cortical bone of the tibia. We diagnosed this fracture as the cause of the patient's sudden difficulty walking.

After two months of cast fixation and non-weight-bearing conservative treatment to allow bone healing (Fig. 2), we decided to perform revision TKA surgery. The preoperative knee joint range of motion (ROM) was 0-45°, the extension lag was 0°, and the Knee Society Score (KSS) 2011 was 24 points.

Surgical method

The Shiers hinge-type artificial knee joint (1954) was used, it was representing at the transitional period from the interpositional membrane arthroplasty to the hinge-type knee arthroplasty³⁾.

Computed tomography (CT) showed a huge bone defect on the proximal lateral side of the tibia (Fig. 3a, b); therefore, a model was created with a three-dimensional (3D) printer, and a surgical simulation was performed (Fig. 4a, b).

Surgery was performed under general anesthesia with a tourniquet. The patella had already been surgically removed at the time of the injury due to a severe comminuted open fracture, and joint exposure was achieved from inside the scarred patellar tendon-like tissue. The implant junction was able to be disassembled by removing the core rod of the hinge portion, allowing easy removal of both femoral and tibial components (Fig. 5).

The height of the tibial osteotomy was determined such that the contact area with the tibial host bone was at least two-thirds of the total circumference. As a result, it was difficult to preserve the medial collateral ligament (MCL) attachment site; therefore, a tumor prosthesis was chosen. The implant used for



Fig. 3 CT showed tomography revealed a large bone defect on the proximal lateral side of the tibia. a) Coronal slice and b) sagittal slice.

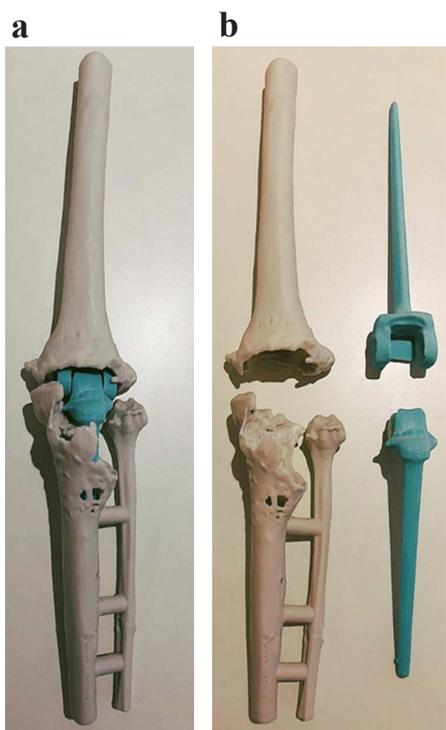


Fig. 4 Models of bone and components were created using a 3D printer. a) Components were inserted and b) removed.

this case was the cemented OSS™ Orthopaedic Salvage System (Zimmer Biomet, Warsaw, Indiana, USA). Consequently, the tibia was osteotomized at approximately 30 mm from the articular surface.

Regarding the defect in the proximal lateral part of the tibia, the scar tissue membrane around the remaining cement block was considered to be an induced membrane; therefore, the



Fig. 5 Removed components and cement block. There was no evidence of metallosis or damage to the hinge.

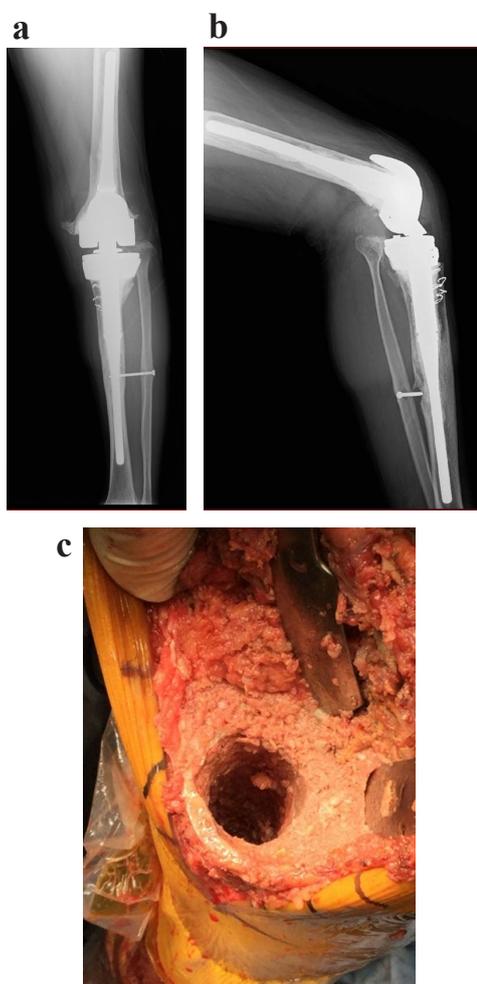


Fig. 6 The tibial bone defect was reconstructed using the IBG technique without mesh reinforcement. a) Postoperative X-ray AP view, b) lateral view, and c) tibial bone after grafting.

defect was reconstructed using an allograft impaction bone graft (IBG) without mesh reinforcement (Fig. 6a, b, c). As the patella had been surgically removed at the time of the injury,

and the only extension mechanism was scar tissue, the Fiber Wire[®] was looped through the scar tissue and fastened to the suture hole of the tibial component, followed by casting in the knee extension position for four weeks. The patient was allowed to walk with full weight while wearing the cast, and ROM exercises were performed after the cast was removed.

Results

When the cast was removed four weeks after the surgery, the patient was able to walk independently, and six months after the surgery, he started playing golf and was able to move up and down stairs without handrails. Although his knee extension lag remained at 5°, his passive ROM improved to 0-80°. It has now been 3 years since the surgery, and the patient's KSS2011 score has improved to 85 points. X-ray shows that the grafted bone has been incorporated with no loosening of the implant.

Discussion

TKA implants have long-term durability owing to the low wear of polyethylene liners, and the surgical application to younger patients is expanding^{4,5}, but previously it was mainly indicated for middle-aged and elderly patients. Therefore, it is rare to observe a patient who has undergone surgery over 30 years ago.

The TKA implants currently in use are so-called total condylar type implants; however, various designs of TKA implants have been attempted, such as the hinge type and link type. In the present study, a hinge-type artificial knee joint developed by Shiers in 1953 was used. While few papers concerning this model have been published, relevant reports can be found up to 1976.

Shiers et al. reported that the first version of the implant resulted in early revision surgery in 11 of 28 patients after 46 months of follow-up^{3,6}. The causes were tibial stem fracture in seven cases, knee joint fusion in two cases, femoral perforation in one case, and infection in one case. Subsequently, the stem length was changed to address tibial stem fracture. According to Watson et al., the clinical outcomes of this model for 33 patients with rheumatoid arthritis involving 42 knee joints at 2-7 years postoperatively were unfavorable. Although implant fractures were no longer observed, mechanical loosening was observed in 35 cases⁷.

The present patient represents an extremely rare case in which a Shiers-type knee prosthesis, which had poor short-term results, remained highly active for nearly 50 years despite being used by an active teenager. Although the removed components had become loosened, there was no evidence of metallosis or damage to the hinge, and they remained inside the patient's body in extremely good condition. To our knowl-

edge, there have been no reported cases of TKA with a 50-year follow-up. One possible reason for the long-term asymptomatic condition in this case is that, despite significant implant loosening, there was marked ROM restriction without instability, and alignment within the bones was well maintained.

The method of dealing with tibial bone defects during revision TKA has historically been based on the Anderson classification proposed by Engh et al.⁸, but this has changed over time thanks to the development of metal augmentation, which has an ultra-porous structure and is advantageous for osteoconduction⁹. Contained-type defects can be treated with morselized bone grafts or cement filling if they are small, but large trapezoid-type defects can be treated with cone-type metal augmentation, which can provide bony support. Reconstruction methods for uncontained tibial bone defects include metal augmentation, bulk allograft bone grafting, and IBG, by creating a wall with a mesh cage. For large defects, such as those ≥ 15 mm from the articular surface, it is difficult to preserve ligament insertion, making it necessary to use a tumor prosthesis¹⁰.

Since the tibia in the present patient had a large bone defect on the proximal and lateral sides after component removal, a method of reconstruction needed to be devised. X-ray and CT showed that the defect was filled with a substance that appeared to be bone cement, and it was naturally assumed that there was no union with the host bone. The Masquelet technique¹¹ used in pseudarthrosis surgery involves temporary placement of cement to close bone defects that occur during pseudarthrosis, and cancellous bone grafting is performed while preserving the membrane. This method enables the reconstruction of massive bone defects. In the present case, because a cement mass had been left in the defect for a long period of time, we suspected that the defect could be reconstructed by cancellous bone grafting, as in the Masquelet-like technique; therefore, we used IBG of morselized bone from the allograft of the femoral head. The tibial component was then fixed using cement.

In the present case, the height of the tibial osteotomy was set to preserve the host bone as much as possible and ensure that the component and host bone were in contact and fixed over an area of approximately two-thirds of the total circumference of the tibia. The contact area between the host bone and tibial component was sufficient, and the long tibial stem provided additional long-axis stability, making it possible to carry out full weight-bearing walking from an early stage after surgery.

TKA after patellectomy is reported to have inferior postoperative outcomes compared to TKA with an intact patella¹². Therefore, patellar reconstruction methods using autografts,

allografts, and augmentation have been reported. In methods using autografts, George et al. reported favorable results in two cases using the distal femur resected as a “neo-patella”¹³⁾. There are also patella reconstruction methods using allografts. Busfield et al. reported a reconstruction method using a whole patella allograft (patellar ligament, whole patella, quadriceps tendon), but severe complications, such as infection, partial resorption of the patella, and fragmentation, occurred in seven out of nine knees¹⁴⁾. In addition, Kwong et al. performed PF arthroplasty or TKA after patellectomy using a tantalum-based augmentation patella, but three out of seven cases experienced early severe loosening, leading them to argue against this method¹⁵⁾. In our case, because there was no extension lag preoperatively, patellar reconstruction was not attempted. Instead, the Fiber Wire[®] was looped through the scar tissue and fastened to the suture hole of the tibial component.

Conclusion

This report details revision TKA performed to address the loosening of a hinge-type knee arthroplasty about 50 years ago. For large defects in the proximal tibia, the use of IBG with the Masquelet-like technique allows for successful bone reconstruction.

REFERENCES

- 1) Shan L, Shan B, Suzuki A, Nouh F, Saxena A. Intermediate and long-term quality of life after total knee replacement: a systematic review and meta-analysis. *J Bone Joint Surg Am* 2015; 97(2): 156-68.
- 2) Chmell MJ, Scott RD. Total knee arthroplasty in patients with rheumatoid arthritis. An overview. *Clin Orthop Relat Res* 1999; (366): 54-60.
- 3) Shiers LG. Arthroplasty of the knee; preliminary report of new method. *J Bone Joint Surg Br* 1954; 36-B(4): 553-60.
- 4) Goh GS-H, Liow MHL, Bin Abd Razak HR, Tay DK-J, Lo N-N, Yeo S-J. Patient-Reported Outcomes, Quality of Life, and Satisfaction Rates in Young Patients Aged 50 Years or Younger After Total Knee Arthroplasty. *J Arthroplasty* 2017; 32(2): 419-25.
- 5) Keeney JA, Eunice S, Pashos G, Wright RW, Clohisy JC. What is the evidence for total knee arthroplasty in young patients?: a systematic review of the literature. *Clin Orthop Relat Res* 2011; 469(2): 574-83.
- 6) Shiers LGP. Arthroplasty of the knee. *J Bone Joint Surg Br* 1960; 42-B(1): 31-9.
- 7) Watson JR, Wood H, Hill RC. The Shiers arthroplasty of the knee. *J Bone Joint Surg Br* 1976; 58(3): 300-4.
- 8) Engh GA, Parks NL. The management of bone defects in revision total knee arthroplasty. *Instr Course Lect* 1997; 46: 227-36.
- 9) Lombardi AV, Berend KR, Adams JB. Management of bone loss in revision TKA: it's a changing world. *Orthopedics* 2010; 33(9): 662.
- 10) Surendran S, Gopinathan P. Tibial bone loss in revision TKA: Options for management without sleeves and cones -a schematic review. *J Orthop* 2021; 23: 191-8.
- 11) Masquelet AC, Fitoussi F, Begue T, Muller GP. Reconstruction of the long bones by the induced membrane and spongy autograft. *Ann Chir Plast Esthet* 2000; 45(3): 346-53.
- 12) Lennox DW, Hungerford DS, Krackow KA. Total knee arthroplasty following patellectomy. *Clin Orthop Relat Res* 1987; (223): 220-4.
- 13) George DA, Dosani A, Morgan-Jones R. Patellar reconstruction following previous patellectomy: a review of the literature and a case series using distal femoral autograft during total knee arthroplasty. *Ann R Coll Surg Engl* 2017; 99(3): e97-101.
- 14) Busfield BT, Ries MD. Whole patellar allograft for total knee arthroplasty after previous patellectomy. *Clin Orthop Relat Res* 2006; 450: 145-9.
- 15) Kwong Y, Desai VV. The use of a tantalum-based Augmentation Patella in patients with a previous patellectomy. *Knee* 2008; 15(2): 91-4.

約 50 年前に行われたヒンジ型人工膝関節で脛骨巨大欠損を伴う弛みに対して 再置換を行った 1 例

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【症例】 63 歳男性, 主訴は左膝から下腿の疼痛による歩行困難。

【現病歴】 15 歳時に交通事故により重度の左膝開放脱臼骨折を受傷した。当時の医療レベルでは再建困難な脛骨巨大欠損があったが、大腿切断ではなく、当時は信頼性の乏しかった人工関節による患肢温存が選択された。術後経過は良好で、成人後は、身体障害者ゴルフの選手となるほど活動性は高かった。62 歳時より膝の不安定感が生じ、その後疼痛で歩行困難となり当科受診。単純 X 線にて大腿骨、脛骨両方のコンポーネントの弛みと菲薄化による脛骨骨折が見られ、2ヶ月間の外固定による保存治療後、TKA 再置換術を行った。

【手術方法】 使用されていた機種は Shiers (1953 年) というヒンジ型人工関節であった。ヒンジの結合部の支柱を叩き出して分離した後、大腿骨・脛骨コンポーネントとも容易に抜去可能であった。脛骨の母床への接触面積が全周の 3 分の 2 以上となるように骨切り部を決め、脛骨外側部の欠損に対しては、同種骨移植を用いた Impaction bone graft 法で、メッシュは用いず外側の癒痕膜を cement block による induced membrane と考え欠損再建を行った。MCL 付着部以遠の骨切りとなるため、腫瘍用インプラントを選択した。膝蓋骨は存在せず伸展機構は癒痕組織のみであった為、ファイバーワイヤーで脛骨インプラントと締結後、4 週間のギプス固定とした。

【結果】 術後 1ヶ月で独歩獲得、6ヶ月でゴルフを再開した。現在術後 3 年で移植骨は生着しており、インプラントの弛みはない。KSS2011 は術前 24 点から術後 85 点まで改善した。

【結語】 約 50 年前に行われたヒンジ型人工膝関節で、脛骨巨大骨欠損を伴う弛みに対する再置換を行う極めて稀な症例を経験したので詳細を報告する。