

World Journal of *Clinical Cases*

World J Clin Cases 2023 April 6; 11(10): 2123-2362



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ABOUT COVER

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The primary aim of *World Journal of Clinical Cases* (WJCC, *World J Clin Cases*) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality clinical research articles and communicate their research findings online.

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The WJCC is now abstracted and indexed in Science Citation Index Expanded (SCIE, also known as SciSearch®), Journal Citation Reports/Science Edition, Current Contents®/Clinical Medicine, PubMed, PubMed Central, Scopus, Reference Citation Analysis, China National Knowledge Infrastructure, China Science and Technology Journal Database, and Superstar Journals Database. The 2022 Edition of Journal Citation Reports® cites the 2021 impact factor (IF) for WJCC as 1.534; IF without journal self cites: 1.491; 5-year IF: 1.599; Journal Citation Indicator: 0.28; Ranking: 135 among 172 journals in medicine, general and internal; and Quartile category: Q4. The WJCC's CiteScore for 2021 is 1.2 and Scopus CiteScore rank 2021: General Medicine is 443/826.

RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: *Xu Guo*; Production Department Director: *Xiang Li*; Editorial Office Director: *Jin-Lei Wang*.

NAME OF JOURNAL

World Journal of Clinical Cases

ISSN

ISSN 2307-8960 (online)

LAUNCH DATE

April 16, 2013

FREQUENCY

Thrice Monthly

EDITORS-IN-CHIEF

Bao-Gan Peng, Jerzy Tadeusz Chudek, George Kontogeorgos, Maurizio Serati, Ja Hyeon Ku

EDITORIAL BOARD MEMBERS

<https://www.wjgnet.com/2307-8960/editorialboard.htm>

PUBLICATION DATE

April 6, 2023

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INSTRUCTIONS TO AUTHORS

<https://www.wjgnet.com/bpg/gerinfo/204>

GUIDELINES FOR ETHICS DOCUMENTS

<https://www.wjgnet.com/bpg/GerInfo/287>

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH

<https://www.wjgnet.com/bpg/gerinfo/240>

PUBLICATION ETHICS

<https://www.wjgnet.com/bpg/GerInfo/288>

PUBLICATION MISCONDUCT

<https://www.wjgnet.com/bpg/gerinfo/208>

ARTICLE PROCESSING CHARGE

<https://www.wjgnet.com/bpg/gerinfo/242>

STEPS FOR SUBMITTING MANUSCRIPTS

<https://www.wjgnet.com/bpg/GerInfo/239>

ONLINE SUBMISSION

<https://www.f6publishing.com>



Treatment of periprosthetic knee infection and coexistent periprosthetic fracture: A case report and literature review

Lin-Jie Hao, Peng-Fei Wen, Yu-Min Zhang, Wei Song, Juan Chen, Tao Ma

Specialty type: Surgery

Provenance and peer review:

Unsolicited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's scientific quality classification

Grade A (Excellent): 0

Grade B (Very good): 0

Grade C (Good): C

Grade D (Fair): D

Grade E (Poor): 0

P-Reviewer: Oommen AT, India; Primadhi RA, Indonesia

Received: December 15, 2022

Peer-review started: December 15, 2022

First decision: January 20, 2023

Revised: February 8, 2023

Accepted: March 6, 2023

Article in press: March 6, 2023

Published online: April 6, 2023



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Abstract

BACKGROUND

Periprosthetic joint infection (PJI) and periprosthetic fracture (PPF) are among the most serious complications following total knee arthroplasty. Herein, we present one patient with these two complications with details on the characteristics, treatment strategy, and outcome.

CASE SUMMARY

A 69-year-old female patient who suffered from PJI and PPF following total knee arthroplasty was treated by a two-stage revision surgery. After thorough foreign material removal and debridement, we used a plate that was covered with antibiotic-loaded bone cement to link with a hand-made cement spacer to occupy the joint space and fix the fracture. Although the infection was cured, the fracture did not heal and caused bone defect due to the long interval between debridement and revision. In the revision surgery, a cemented stem and cortical allogenic splints were used to reconstruct the fracture and bone defect. At the final follow-up 27 mo after revision, the patient was satisfied with postoperative knee functions with satisfactory range of motion (104°) and Hospital for Special Surgery knee score (82 points). The radiographs showed no loosening of the prosthesis and that the bone grafts healed well with the femur.

CONCLUSION

Our two-stage revision surgery has proved to be successful and may be considered in other patients with PJI and PPF.

Key Words: Knee arthroplasty; Periprosthetic joint infection; Periprosthetic fractures; Complications; Surgical revision; Case report

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Core Tip: Periprosthetic joint infection (PJI) and periprosthetic fracture (PPF) are among the most serious complications of knee arthroplasty. A two-stage revision surgery should be progressively performed in the treatment of PJI and coexistent PPF with bone loss. In the first-stage operation, a T-shaped cement spacer made from a rectangular vancomycin laden cement block and a cement coated plate was used after debridement. In the second-stage operation, the combination of cemented prosthesis and freeze-dried cortical allogenic splints were used for knee revision and fixation of PPF. Our approach offers an option for successful treatment of PJI and PPF.

Citation: Hao LJ, Wen PF, Zhang YM, Song W, Chen J, Ma T. Treatment of periprosthetic knee infection and coexistent periprosthetic fracture: A case report and literature review. *World J Clin Cases* 2023; 11(10): 2321-2328

URL: <https://www.wjgnet.com/2307-8960/full/v11/i10/2321.htm>

DOI: <https://dx.doi.org/10.12998/wjcc.v11.i10.2321>

INTRODUCTION

For patients with posttraumatic osteoarthritis, the presence of periarticular hardware complicates total knee arthroplasty (TKA) and increases the incidence of periprosthetic joint infection (PJI)[1-3]. Meanwhile, PJI may significantly prolong the treatment period, resulting in longer hospitalization, more complications, higher medical costs, and lower quality of life[4-6]. Periprosthetic fracture (PPF) is also one of the most serious complications after TKA and usually results in joint dysfunctions or even disabilities[7]. Patients may suffer from both PJI and PPF simultaneously, which makes a therapeutic approach difficult to formulate because of different or contradicting treatment concepts. Once an infection occurs, all foreign materials including prosthesis and internal fixation need to be removed; however, PPF needs to be stabilized by internal fixation. Therefore, the most crucial question is how to deal with both fracture fixation and infection treatment appropriately.

In this case report, we describe a patient with concomitant PJI and PPF who was successfully treated and followed for 2 years.

CASE PRESENTATION

Chief complaints

A 69-year-old Chinese woman was admitted to our joint clinic with a complaint of right thigh pain and swelling for 3 d.

History of present illness

Symptoms started 3 d before presentation with severe thigh pain and swelling (July 2019).

History of past illness

The patient fell and fractured her right distal femur in November 2017. She underwent an open reduction and internal fixation (ORIF) at a local hospital. In December 2018, the patient was diagnosed with posttraumatic osteoarthritis of the right knee, for which the removal of original internal fixation implants and TKA were simultaneously performed (Figure 1A and B). In April 2019, the patient suffered PJI of the right knee with a sinus formation and was treated with antibiotic suppression; however, the infection did not improve.

Personal and family history

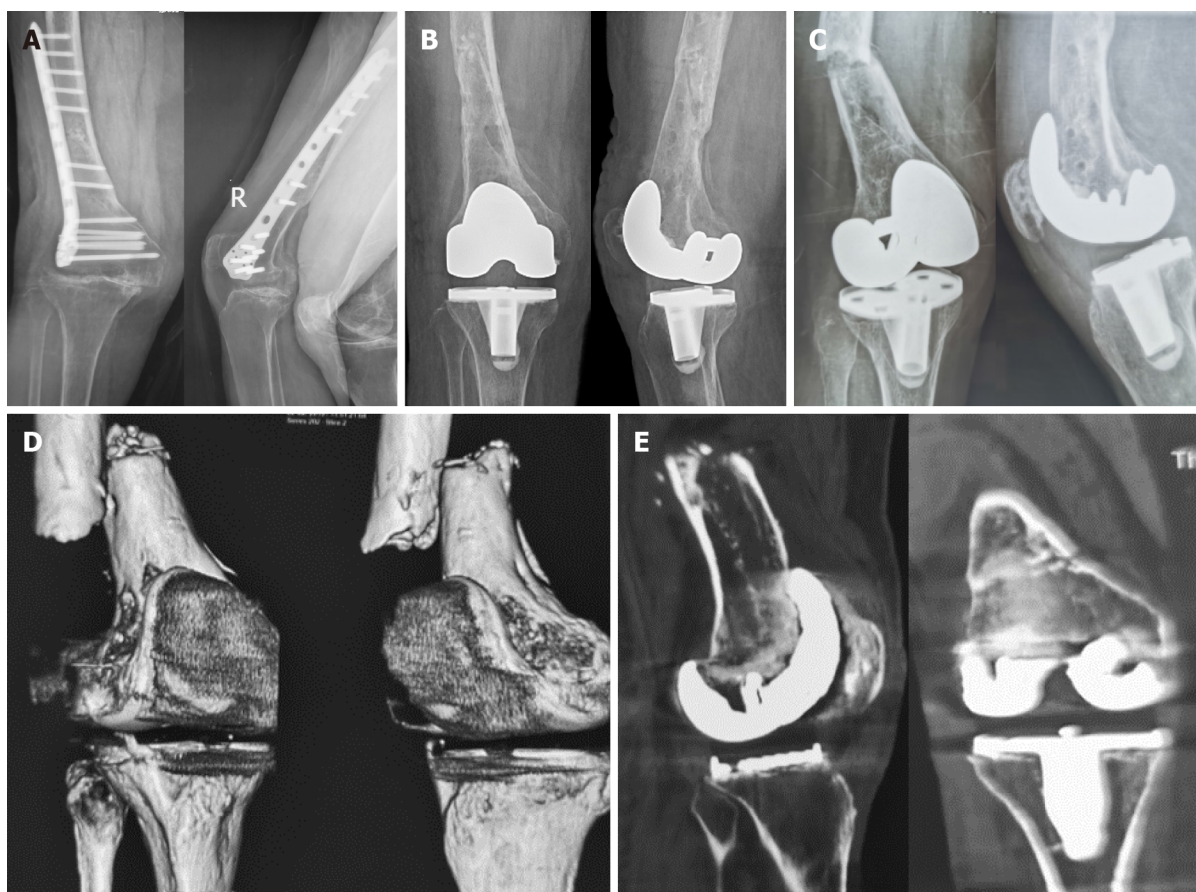
The patient had no personal or family history.

Physical examination

The right thigh was swollen and deformed. The right knee had a sinus tract and limited range of motion.

Laboratory examinations

The serum erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), white blood cell (WBC) count, and neutrophil percentage were elevated (97 mm/h, 126.19 mg/L, $12.18 \times 10^9/L$, and 75.2%, respectively). The synovial fluid WBC count and synovial fluid polymorphonuclear neutrophil percentage were 12045/uL and 94%, respectively. Methicillin-resistant *Staphylococcus aureus* (MRSA) was detected on the synovial fluid culture.



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Figure 1 X-ray and computed tomography images. A: Anterior–posterior and lateral X-ray images of the right knee before primary total knee arthroplasty showing an end-stage osteoarthritis of the right knee with valgus deformity and a hardware fixed on right femur without signs of fracture (December 2018); B: Anterior–posterior and lateral X-ray images of the right knee after the primary total knee arthroplasty showing satisfactory position of the knee prosthesis and that the original hardware was completely removed without fracture (December 2018); C: Anterior–posterior and lateral X-ray images of the right knee after fall showing the distal femur fracture with significant displacement and that the knee prosthesis was seemingly stable (July 2019); D: Three-dimensional computed tomography (CT) images showing fractures of the right distal femur with severe displacement (July 2019); E: Coronal and sagittal CT images showing radiolucent lines around the femoral and tibial prosthesis (July 2019).

Imaging examinations

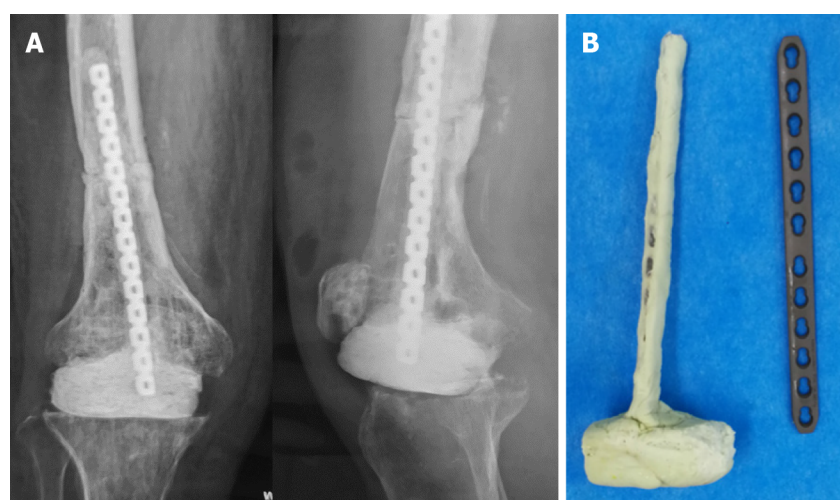
The X-ray and computed tomography (CT) scan revealed a fracture of the right femur and loosening of the knee prosthesis (Figure 1C-E).

FINAL DIAGNOSIS

The patient was diagnosed with PJI and PPF (Rorabeck and Taylor[8] type II) of the right knee.

TREATMENT

A two-stage revision surgery was planned with an interval of about 3 mo. The first-stage operation (Figure 2) was performed in two steps. The first step was resection of the prosthesis and debridement. The second step was the placement of an antibiotic cement spacer and fixation of PPF. We used a rectangular vancomycin laden cement (Palacos R+G, Heraeus Medical GmbH) block linking with a cement-coated plate (Limited contact dynamic compression plate, Synthes GmbH) to make a T-shaped spacer. A longer plate was not selected to avoid the spread of infection. Five different specimens around the prosthesis were sent for culture, and the detected pathogen was still MRSA. An infectious disease specialist prescribed a regimen of anti-MRSA drugs, consisting of intravenous drip of vancomycin and oral rifampicin at dosages of 1000 and 600 mg/d, respectively. After 2 wk, the regimen was changed to 300 mg/d of oral rifampicin and 500 mg/d of oral ciprofloxacin for 6 wk. After the operation, the patient was instructed to walk without weight-bearing. However, the patient was lost to follow-up and



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Figure 2 X-ray and intraoperative images. A: Anterior–posterior and lateral X-ray images of the right knee after the first stage operation showing favorable position of the cement spacer and satisfactory reduction and fixation of the femoral fracture (July 2019); B: A hand-made T-shaped antibiotic-laden cement spacer for knee gap occupation and femoral fracture fixation.

did not undergo the second-stage operation (Figure 3) in October 2019 as planned. In May 2020, she revisited our outpatient clinic. By this time, she had suffered severe functional impairment with a Hospital for Special Surgery (HSS) knee score of only 23 points. She was admitted into the hospital. After infection was ruled out through a series of blood tests and synovial fluid culture, the second-stage operation consisting of ORIF of PPF and revision TKA was performed in three steps. First, we performed debridement and removed any foreign material and sequestrum. Second, the fixation of periprosthetic femoral fracture was done. Two pieces of freeze-dried cortical allogenic splint (Shanxi Aorui Biomaterials Co. LTD) of approximately 10 centimeter in length were used for auxiliary fixation of the femur. Then, cables (Synthes Cable System) and wires were used to bundle bone splits, and autologous bone graft was applied to the bone defect. Finally, knee revision prosthesis (NexGen LCCK, Zimmer Inc.) was installed. A 150-millimeter-long stem with a diameter of 14 millimeters was used on the femoral side. A 100-millimeter-long stem with a diameter of 14 millimeters was used on the tibial side. A 5-millimeter-thick metal pad was added to both medial and lateral sides of the distal femoral prosthesis, and a 10-millimeter-thick metal pad was added to the posterior condyle of the femoral prosthesis. X-rays were taken at 3 d postoperatively. Postoperative rehabilitation exercise consisted of partial weight bearing of the right lower limb for 6 wk. The antibiotic therapy was continued according to the instructions of the infectious disease specialist. A timeline of the clinical course and management is provided in Table 1.

OUTCOME AND FOLLOW-UP

The patient was followed periodically (6, 12, and 24 wk and annually thereafter) after revision TKA. The wound healed well without redness or swelling. The serum CRP and ESR decreased continuously and returned to normal at 3 mo post-revision. The HSS score was 59, 69, and 85 points at 6, 12, and 24 wk after revision, respectively. At the final follow-up 27 mo after revision (Figure 4), the range of motion was 104°, the HSS score was 82 points, and the Western Ontario MacMaster Universities Osteoarthritis Index score was 36 points. The patient was satisfied with the course of treatment and postoperative knee function. There was no sign of infection recurrence or loosening of the prosthesis.

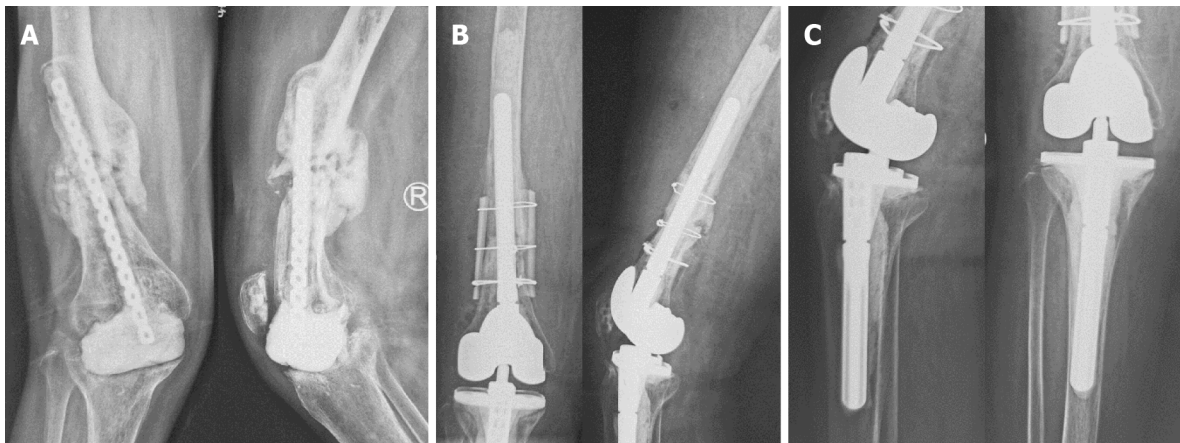
DISCUSSION

PJI and PPF are among the most serious complications following TKA and usually raise concern for both patients and surgeons[9-11]. The incidence of PJI after primary TKA is 0.7%-2% [12,13], while that after revision is 5.6%-35% [14-16]. Meanwhile, the incidence of PPF ranges from 0.3% to 2.5% after primary TKA and 1.6% to 38% after revision TKA [17-19]. Each complication needs precise assessment and specific care to prevent further serious issues. If PJI is simultaneous with PPF for one patient, it is going to be a very tricky situation. There is no optimal management strategy regarding this issue due to lack of standards and controversy over treatment effectiveness. The treatment of this patient for

Table 1 Overview of the timeline of the clinical history, diagnosis, and treatment

Date	Diagnosis	Treatment
November 17	Right femoral fracture	ORIF
December 18	Posttraumatic osteoarthritis of right knee	Removal of internal fixation and TKA
April 19	PJI	Antibiotic suppression
July 19	PJI and PPF	Resection of prosthesis with placement of antibiotic spacer and fixation of fracture
May 20	Post-operation of prosthesis removal	Revision knee arthroplasty and fixation of right PPF

ORIF: Open reduction and internal fixation; TKA: Total knee arthroplasty; PJI: Periprosthetic joint infection; PPF: Periprosthetic fracture.



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Figure 3 X-ray images. A: Anterior–posterior and lateral X-ray images of the right knee before the second stage operation showing that the cement spacer slightly displaced to the medial side, the proximal end of internal fixator came out through the middle femoral shaft, callus formed at the previous fracture of the femur but not healing yet, and bone defects existed in the distal femur and proximal tibia, which resulted in valgus deformity of the right knee (May 2020); B and C: Anterior–posterior and lateral X-ray images of the right knee after the second stage operation showing no loosening of cemented revision knee prosthesis and that the femoral fracture was fixed with intramedullary stem and extramedullary cortical splints (May 2020).

infection and fracture after TKA with periarticular internal fixators offers possible strategies for this condition.

The incidence of PJI in patients with a history of ORIF who underwent TKA is similar to that after revision[20]. Suzuki *et al*[21] reported that previous ORIF and remnants of previous internal fixation materials showed significant correlation with postoperative infections. A prospective matched cohort study conducted by Lizaur-Utrilla *et al*[22] found that the incidence of surgical site infection was higher in the posttraumatic group and recommended removal of hardware prior to TKA. In contrast, Klatte *et al*[23] found that the risk of developing periprosthetic knee infection was not significantly increased with pre-existing orthopaedic implants. In general, more and more studies identified previous fracture history and remnants of pre-existing fixation-devices as major risk factors for PJI after TKA[21,22,24] and suggested that complete removal of the fixators 4 to 6 mo before TKA could reduce the incidence of PJI[22,25]. For clinical implication, surgeons should be conscious of the infection potential when performing knee arthroplasty on patients with these risk factors.

From our point of view, fixing the fracture is the main difficulty for patients with both PJI and PPF and also is an important factor to ensure fracture union and prevent postoperative infection. In this study, the combination of antibiotic-laden cement spacer and cement-coated plate, which was used as an intramedullary nail, provided a solution. Bonacker *et al*[26] presented a two-stage surgical strategy conducted in a 69-year-old male patient with a periprosthetic tibia fracture, infectious nonunion, and loosening of the TKA due to ascending infection. After removing all implants, a deep debridement was performed, and a tibial nail connected with a hand-formed bone cement knee spacer including antibiotics and two additional antibiotic-impregnated chains was implanted. In the revision surgery, the tibial fracture site was stabilized with a long uncemented stem. Sanz-Ruiz *et al*[27] presented a biarticular cement spacer, made from a cephalomedullary nail, to treat infected hip arthroplasty with massive bone loss. They covered the nail with antibiotic-laden cement and obtained satisfactory results of infection control and functional retention. In this case, a cement-coated plate which can slowly release antibiotics, preventing bacterial adhesion and proliferation and biofilm formation, was also used to



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Figure 4 X-ray images. Anterior–posterior and lateral X-ray images showing a large amount of new bone formed between the cortical splits and femoral shaft with no loosening of the knee prosthesis (August 2022).

substitute a metal-exposed plate as intramedullary nail for fracture immobilization. In addition, a cemented femoral stem was used instead of cementless one during the revision, because a fully long cementless stem could not be implanted due to the anterior femoral curvature and large defect of the previous fracture. Meanwhile, the cemented one could stabilize the proximal and distal parts of femoral fracture. What needs illustration is that cement smeared at the fracture was strictly prohibited and measure of heat control was indispensable when the cement generate heat during solidification to avoid affecting the union of fracture.

Müller *et al* [28] reported a two-stage revision for the treatment of 8 patients with PPF and infection. The fractures were fixed by three strategies: 2 patients by plate, 3 by intramedullary rod/pin, and 3 by plate and rod/pin. At the final follow-up, one infection recurred, and three individuals developed nonunion of fracture, getting a high nonunion rate. A systematic review conducted by Ebraheim *et al* [29] concluded that the complication rate of PPF after TKA separately treated with intramedullary nail/rod or locking plate is as high as 53% and 35%, respectively, and the most common complication is non/delayed union. Therefore, to ensure fracture healing, it is necessary not only to cure infection, but also to obtain the fixation stability of the fracture. In such revision surgery, extramedullary auxiliary fixation is often required if intramedullary stem cannot guarantee the fixation stability of fracture. Except for plates, bone splints are commonly used. Carta *et al* [30] reported that cortical allogenic splints should be considered the use instead of metal plates for the treatment of periprosthetic femoral fracture, which usually has bone loss and/or a potential mechanical instability. In a cadaveric study, Peters *et al* [31] concluded that allograft cortical splints offer biomechanical advantages as an alternative to metal plates for the fixation of femur fracture below a well-fixed femoral component. In this study, we used titanium cable and wires to fix the two splints which were placed on the medial and lateral aspects of the femur. Then, bone graft was also performed. Comparing with using single metal plates, we could get potential benefits from the use of cortical allogenic splints, which can increase bone quantity and quality, decrease stress shielding, stabilize the entirety, so as to reduce fracture nonunion occurrence and other complications, and improve the patients' quality of life by accelerating function recovery. However, the potential disadvantages of the customized transplant, such as transmission of infectious diseases, risks of infections, longer surgical time, and more complex surgical procedures, must be taken into consideration.

Another aspect that we have learned from this case is the importance of strengthening patients' management and guidance to avoid similar incidents. In the future, we should establish a more diversified and convenient follow-up system, strengthen the patient education on the post-discharge process, urge patients who need special care to attend follow-up visits regularly, and involve family members in the patient care.

The main limitation of this study is that it is a report of a single case, which is due to the low incidence of the coexistence of PJI and PPF.

CONCLUSION

PJI, PPF, and nonunion with bone defect individually pose a challenge in orthopedics and trauma

surgery. We present a highly complex case on account of the consecutive occurrence of these complications. The lack of standards resulted in the requirement of an individualized strategy under this circumstance, and the key to success was synergistic execution of simultaneous fracture stabilization and infection eradication. Our approach offers an option for successful treatment, upon which future strategies can be developed. Highly specialized interdisciplinary centers are needed for desirable therapeutic outcomes.

FOOTNOTES

Author contributions: Ma T and Zhang YM conceived and performed the surgery; Hao LJ assembled previous reported records and drafted the manuscript; Wen PF, Song W, and Chen J helped perform the surgery and revised the manuscript for important intellectual content; all authors have read and approved the final manuscript.

Supported by the General Cultivation Project of Xi'an Health Commission, No. 2021ms08.

Informed consent statement: Informed written consent was obtained from the patient for the publication of this case report.

Conflict-of-interest statement: All the authors declare that they have no conflict of interest to disclose.

CARE Checklist (2016) statement: The authors have read the CARE Checklist (2016), and the manuscript was prepared and revised according to the CARE Checklist (2016).

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Country/Territory of origin: China

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S-Editor: Liu JH

L-Editor: Wang TQ

P-Editor: Liu JH

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