Two-stage Revision for Salmonella-infected Total Hip Replacement, Complicated by a Periprosthetic Fracture
Mohammad Zeeshan Nasser¹, Nikhil Sharma¹, Peter Shewell¹

Learning Point of the Article:
Importance of identifying rare causes of prosthetic joint infections and to carefully plan revision surgery, keeping in mind factors such as poor bone stock and resolution of infection, to ensure successful outcome.

Abstract
Introduction: Salmonella-infected prosthetic joint infection is rare. We report a patient who developed an infected total hip replacement with Salmonella Typhimurium.

Case Report: A 65-year-old patient presented with atraumatic groin pain and raised inflammatory markers following gastroenteritis. After a decade of conservative management using suppression antibiotics, she underwent a two-stage revision. Her case was further complicated as she fell before her second-stage sustaining a Vancouver C periprosthetic fracture. Once her infection cleared, a complex second-stage revision was performed using components to include reconstruction of the acetabulum with trabecular metal augments and buttresses, a trabecular metal acetabular revision system component and an endoprosthetic replacement of the upper two-thirds of the femur. Approximately 12 months on, the patient is now mobilizing, pain free.

Conclusion: This case emphasizes the need for a good diagnostic work-up and management process, surgical planning and technique, and highlights the importance of a multidisciplinary team involvement in improving outcomes for patients.

Keywords: Prosthetic joint infection, Salmonella, femoral fracture.

Introduction
Prosthetic joint infections (PJIs) are a devastating complication of surgery with an incidence of 1–2% [1, 2]. Staphylococcus is the most common organism implicated in PJI. Salmonella PJI is rare but has been reported within the literature; De la Torre et al. reported on 29 cases in 2012 [3]. Due to the rare occurrence, the management techniques for Gram-negative organisms like Salmonella are not well defined. Herein, we describe a case of a 65-year-old patient who developed a Salmonella Typhimurium infected total hip replacement (THR) further complicated when she sustained a Vancouver C periprosthetic fracture before her second-stage procedure. This case report addresses the technical aspects of her management which we hope may provide a learning aid to clinicians.

Case Report
A 65-year-old patient with a cemented THR presented to our orthopaedic department with progressive atraumatic left groin pain and elevated inflammatory markers (Fig. 1). She originally presented to the medical team a few months earlier suffering from gastroenteritis with positive stool cultures for S. Typhimurium, but did not receive any antimicrobial therapy as her symptoms improved. The primary THR was performed in 1983 because of hip dysplasia following Legg-Calve-Perthes disease; this was revised in 1992 and 2002 both due to aseptic loosening.

Imaging including an isotope bone scan was performed, which demonstrated increased uptake suggestive of infection. The patient was not keen for any major revision surgery and so an
open washout and debridement was performed. All intraoperative samples grew S. Typhimurium which was fully sensitive to amoxicillin; hence, the patient continued suppression antimicrobial therapy with this antibiotic. The patients’ symptoms were adequately controlled for almost 10 years with antibiotics and analgesia, but subsequently, she experienced reduced mobility and worsening pain. A repeat open washout and debridement was performed; one out of four intraoperative samples grew S. Typhimurium. Intravenous ertapenem and oral amoxicillin were continued for 3 months. Despite an initial improvement in inflammatory markers, the patients’ pain and function worsened, and after a detailed discussion, she consented to a two-staged revision.

**Operative technique**

**First stage**

Under a general anesthetic, the patient was positioned on a radiolucent table in the lateral decubitus position. The existing scar (lateral approach) was excised with soft-tissue dissection down to the hip. Extensive soft granulation tissue was found. The hip replacement was dislocated, the femur exposed distally until normal bone was found and then transected. The proximal femur was discarded and the distal cement was removed using an Orthosonics OSCAR 3. In a similar fashion, the acetabular components were exposed and polycup and reinforcement cage removed. The anterior and inferior acetabular rim was found to be intact along with a shelf of the superior medial wall. It was felt that a secondary reconstruction could be attempted during the second-stage revision. Multiple tissue and bone samples were taken and a thorough wash of the acetabulum, femur, and surrounding soft tissue was performed using pulsed lavage. After trialing, a 57 mm Prostalac spacer was filled with gentamicin and meropenem cement and mounted on a 44 No. 1 Exeter stem. A 16 mm cement plug inserted, followed by retrograde cement filling of the femoral canal and insertion of the temporary implant (Fig. 2). Cement was applied to ensure that the entire Exeter implant was covered. Primary wound closure was achieved; the patient was commenced on a 6-week course of IV ertapenem and allowed to mobilize on crutches. Five out of six intraoperative samples were positive for S. Typhimurium. The patient improved both clinically and biochemically such that by 6 weeks post-operative, her CRP had dropped to 10 and her antibiotics were stopped. Unfortunately following a trivial fall a week later, she sustained an ipsilateral Vancouver type C periprosthetic fracture at the level of the tip of her cement spacer (Fig. 3).
Despite several reports in the literature regarding successful treatment of PJI with antibiotic suppression, they are limited in number [6, 7]. Other studies report that antibiotic suppression alone is not sufficient and the prosthesis has to be removed for the infection to be fully treated [3, 8, 9]. One study comparing the effectiveness of treatment with implant retention and two-

The mid femur was transected below the level of the fracture. The distal femur was broached up to 15 mm and a trial stem position checked using image intensifier. The distal femur was irrigated with pulse lavage and packed with ribbon gauze before retrograde filling with Palacos cement and the insertion of a 120 × 13 mm MUTARS distal stem. The femoral body was trialed and final construct assembled using a 100 mm connecting part, 40 mm extension piece, and 50 mm proximal femur with appropriate screws. A +4 mm neck sleeve with 28 mm head was used in a 46 mm stabilized polydual mobility head (Fig. 4). A reinforcement soft-tissue jacket was inserted over the prosthesis and the anterior and posterior soft tissues at the level of the greater trochanter were sutured to this. Following thorough wound irrigation, the soft tissues were closed in layers with clips to skin.

Following from this extensive second-stage procedure, the patient remained well; intraoperative samples on extended culture were negative and IV ertapenem was stopped after 2 weeks duration. After 6 months, the patient remains pain free, with normal inflammatory markers and despite shortening of 2 cm is mobilizing independently with the use of crutches and has returned to work (Fig. 5).

This patient suffered from gastroenteritis few months before developing a PJI, which is the prodromal symptom in about 40% of the cases [5]. Having gone through numerous complicated operations in the past, she was reluctant to go ahead with further major surgery. After repeated consultations, it was agreed that a minimally invasive approach would be adopted and so she underwent an open washout and debridement to take samples and to reduce the bacterial load with antibiotic suppression. There were detailed discussions in a joint orthopedic and microbiology MDT meetings and her infection was successfully suppressed with amoxicillin for 10 years.

Salmonella-infected PJI is a rare occurrence with an associated high morbidity and mortality. Salmonella is a Gram-negative bacillus and implicated in gastroenteritis and can cause bacteremia with seeding resulting in infections involving native and prosthetic joints [4].

The previous scar was excised and extended both proximally and distally with soft-tissue dissection down to the hip joint. All tissue planes appeared healthy. The cement spacer was removed to allow inspection of the acetabulum revealing an absent anterior wall, with a large superior and posterior segmental and cavitary defect. The sciatic nerve could not be palpated due to thick surrounding scar tissue. The acetabulum was reamed to 68 mm and reconstructed using a 58 × 10 mm augment anterosuperiorly cemented to a 68 mm trabecular metal acetabular revision system (TMARS) shell. Two superior screws were inserted through the TMARS shell traversing the augment into the superior acetabulum. The lateral wall of the ilium was shaped and petaled with an osteotome to allow the fitting of a posterior buttress augment with a 5° shim. The shim and buttress were first trialed and cemented to the TMARS shell using Palacos; the lateral wall of the ilium was packed with acetabular reaming’s and the posterior buttress plate secured to the lateral wall of the ilium with four screws.

Second stage

The patient was placed in traction and after 2 weeks of antibiotics, to exclude persisting infection, an aspiration in theater from both the remaining hip joint and the fracture site was performed and was negative on extended culture. Stool culture and ultrasound scan of the liver and gallbladder were negative for Salmonella. Reassured of resolution of the infection, a second-stage revision was performed with the aim of bypassing the fracture site and reconstructing the proximal femur.

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Stage revision reported infection control rates of 50% and 78% after initial treatment, and 68% and 82% at latest follow-up, respectively. One of the risk factors identified in the study for implant retention not being successful was those involving revision THR [10]. This mirrored our patients' case. The antibiotic worked initially in reducing pain and suppressing the infection, but her inflammatory markers never returned to normal. Overtime her symptoms progressed necessitating major surgery.

Once surgery has been decided, the next question is what type should be offered. Choices include a further open washout and debridement, excision arthroplasty, or revision arthroplasty. Revision arthroplasty can either performed as a single or staged procedure. There have been several studies done comparing one-stage versus two-stage revision for PJI in hips, but this topic remains controversial. A qualitative study done in 2017, which interviewed revision surgeons about their decision to perform one-stage or two-stage revision, reported that several factors influenced the method used and the need for a prospective randomized control trial to find a standardized surgical intervention for PJI [11]. Wolf et al. conducted a study comparing single- to two-stage revision arthroplasty surgery, based on the classification of joint infections according to McPherson et al. [12], concluded that except for one category, that is, early post-operative infection with no systemic comorbidities and local status uncompromised; two-stage revision is a superior method to eradicate deep prosthetic infections. Eradication of prosthetic infection was achieved in 94.5% within the group of two-stage exchange and 56.8% of the patients treated with one-stage procedure [13].

Gupta et al. published a case series that retrospectively looked at six Salmonella PJIs over a period of 44 years in Mayo Clinic. Similar to our case, two patients in the case study had diarrhea before the symptoms occurred, with one of them having a positive stool culture for Salmonella. Four out of the six patients were initially treated conservatively with aspiration or debridement and antibiotics but this did not prove to be successful as symptoms returned soon (median time 2.5 months). All six patients ultimately required the removal of prosthesis for successful treatment (median follow-up 11 years) of which four had two-stage revisions. They were also given antibiotics for 6–8 weeks. The authors concluded that most patients with PJIs require both antibiotics and surgery for definite management [4].

Our patient had extensive bone stock loss at presentation and sustained a Vancouver C periprosthetic fracture below the cement spacer which further complicated the case. This was likely due in part to disuse osteopenia, resulting in a pathological fracture.

Once infection was excluded, it was decided to perform one operation to address both the second-stage revision and the femoral fracture using a long modular revision stem. Correct component selection is a big issue and is determined by various factors such as stability, leg length discrepancy, and joint mechanics [14]. The acetabular defect was reconstructed with a Zimmer TMARS; a prospective study of hip revision using TMARS acetabular defects with no more than 50% host bone contact suggested that it was a reasonable option [15]. The femur below the original resection level and the fracture was excised because of its poor bone quality and reconstructed using a MUTAR endoprosthesis. Literature suggests that with the modular MUTARS RS stem, the rate of aseptic loosening is only 4.6% [16]. Large defects of the proximal femur have been successfully reconstructed using MUTARS [17].

**Conclusion**

Salmonella-infected PJI is rare often requiring a MDT approach to reduce morbidity and mortality. Such infections can be treated safely with suppressive antibiotics. Our case highlights the importance in obtaining a thorough history and clinical examination to aid the diagnosis; along with the formation of our joint orthopedic and microbiology meeting, we were able to implement an appropriate treatment plan. Surgical treatment can often become complicated in PJI and our case describes how we addressed the concerns of infection, poor bone stock, and a periprosthetic fracture.

**Clinical Message**

A thorough history, examination, and correct investigations are the key to identify rare causes of PJI. It is vital to carefully plan revision surgery, keeping in mind factors such a poor bone stock and resolution of infection, to ensure successful outcome. Finally, the importance of multidisciplinary team involvement and formation of a joint orthopedic and microbiology network can greatly help improve patient outcome.

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