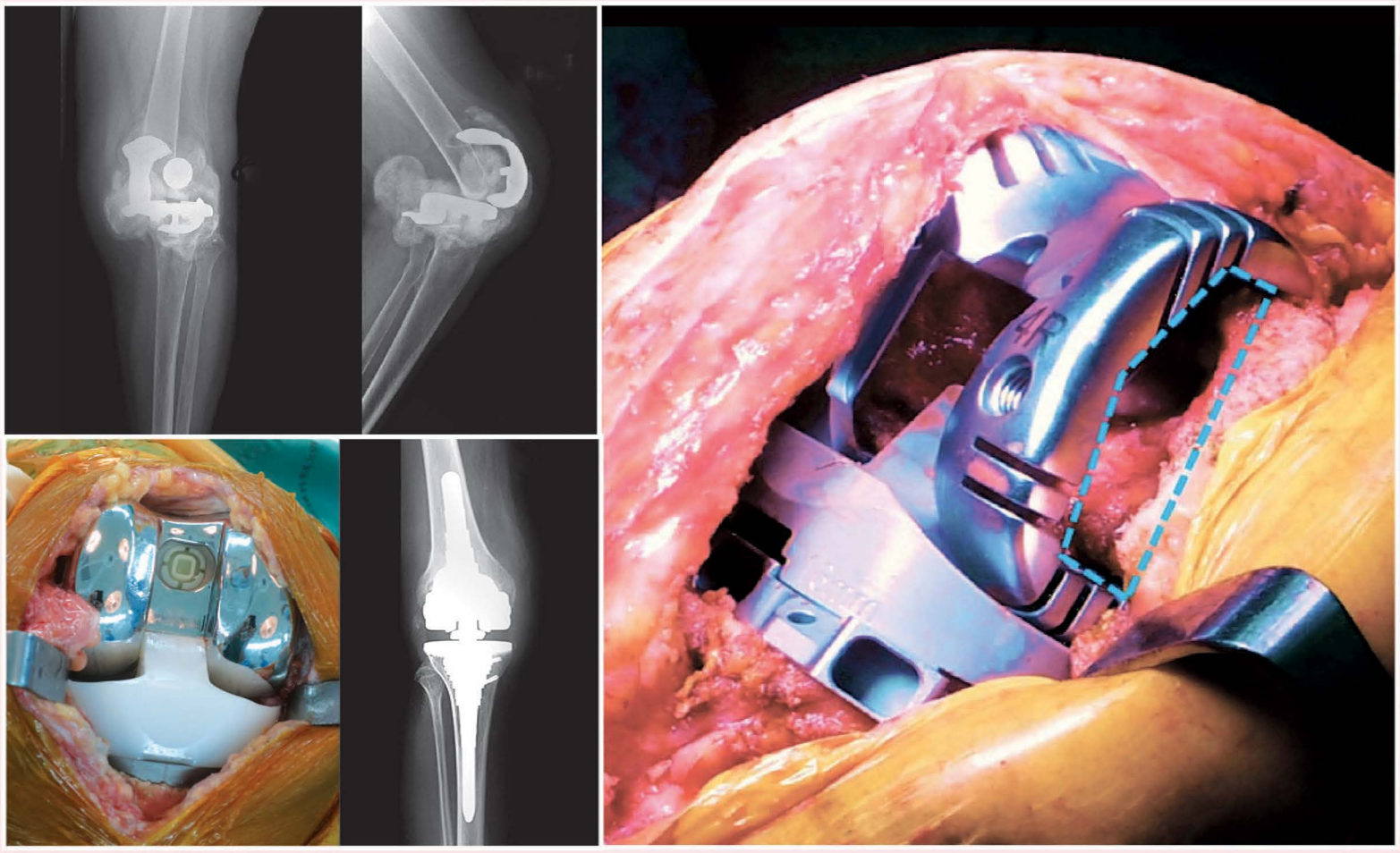
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Mastering Orthopedic Techniques

REVISION KNEE ARTHROPLASTY

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CHAPTER 4

Preoperative Planning in Revision Knee Arthroplasty

Phillip Aristotle R Hermida, Gauguin P Gamboa, David AF Morgan OAM

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Overall results of total knee arthroplasties (TKAs) are excellent, with 95% of the implants surviving for at least fifteen years.[1,2] But the remaining 5% that fail represent a problem for orthopedic surgeons. There is an increasing number of patients who initially had a successful total knee replacement but then had pain, radiographic evidence of failure, and/or dysfunction due to failure of the arthroplasty. Extensive bone loss, instability, infection, dysfunction of the extensor mechanism, and periarticular arthrofibrosis are frequent challenges encountered during revision surgery. A systematic approach to deal with the assessment of patients requiring revision TKA can help arrive at a sound diagnosis and guide the appropriate course of action.

Before deciding on a revision, the surgeon should investigate and ascertain the cause of the pain in a patient who has had a total knee arthroplasty. A revision total knee arthroplasty done for unexplained pain has a very low probability of success.[3] A review of operative record to identify the implant used is not only good clinical practice but an essential first step. A candidate for revision must be optimized to prevent morbidity. Sometimes revision surgery is contraindicated, such as in a patient with Charcot arthropathy or neuromuscular disease. Wound healing after revision total knee arthroplasty is critical to success and is often more difficult to achieve than it is after a primary total knee replacement. If there is doubt about soft-tissue coverage and/or viability, use of a rotational muscle flap or consultation with a plastic surgeon should be considered.

Preoperative Evaluation

The causes of dysfunction and pain after total knee arthroplasty are numerous (*see* Chapter 37).[4-6] A working and complete knowledge of this list improves one's ability to correctly determine the cause(s) of failure.

History and Physical Examination

The history and physical examination are critical first steps in the evaluation of patients with pain after a total knee arthroplasty, and often they alone allow identification and/or elimination of the majority of pathologic etiologies. The primary symptom should be clearly defined (pain, swelling, instability, or stiffness), as should the time of onset, the duration, and the frequency of the symptoms as well as any activities that are associated with them.

Pain that was present prior to the surgery and has persisted without change suggests an extrinsic etiology. Pain that began within the first year after the surgery suggests infection, malrotation, or soft tissue impingement. Pain that began after a year suggests wear, osteolysis, loosening, or infection (acute hematogenous or late chronic). Comorbid conditions, such as diabetes, peripheral vascular disease, and lumbar stenosis, should be considered. The physical examination should include visual inspection; careful palpation (for swelling or point tenderness); stability testing in extension, midflexion, and 90° of flexion;[7,8] and evaluation of patellofemoral stability, including palpation of the patella and its retinaculum. The surgeon should (1) watch the patient walk; (2) measure the active and passive ranges of knee motion; (3) evaluate patellar tracking (patellar clunk refers to impingement of scar tissue on the undersurface of the quadriceps tendon as the knee extends from a flexed position; this is less common with modern trochlear and femoral box designs);[9] (4) perform a thorough neurovascular examination with careful assessment of quadriceps and vastus medialis obliquus strength and the quality and symmetry of peripheral pulses; and (5) examine adjacent joints, including the hip, lumbar spine, foot, and ankle (a planovalgus foot deformity can lead to failure of a cruciate-retaining arthroplasty).[10]

Radiographic Evaluation

Examining plane radiographs can reveal many of the intrinsic causes of pain in a patient who has had a total knee arthroplasty, and examining a prospective series of radiographs, including preoperatively, can be particularly useful. Hip-to-ankle weight-bearing antero-posterior, lateral, and Merchant views of the knee and radiographs of the ipsilateral hip should be evaluated. The anteroposterior radiograph should be scrutinized for evidence of polyethylene wear; osteolysis; radiolucent lines; and overhang, subsidence, or a change in the position of the tibial component. The lateral radiograph should be assessed for the femoral component size, posterior femoral offset, patellar height and thickness, and tibial component slope and subsidence. The Merchant radiograph should be evaluated for patellar tilt, malalignment, femoral overhang, lateral patellofemoral impingement, and patellar composite thickness. Serial radiographs are invaluable for determining subtle signs of loosening, such as late progression of radiolucent lines, changes or fractures in the cement mantle, progression of osteolysis, or subtle change in component position. Fluoroscopic examination may be useful for evaluating the interface in cementless arthroplasty designs. The extent of osteolytic lesions is seen better on computed tomography or magnetic resonance imaging with metal artifact suppression, but these modalities are not universally available.[11] Computed tomography and magnetic resonance imaging can also be used to accurately assess the rotation of the femoral and tibial components; the femoral component is compared with the transepicondylar axis, and the tibial component is compared with the medial third of the tibial tubercle. Excessive internal rotation of either component can be associated with patellar instability[12] and lateral flexion laxity,[13] leading to poorer clinical function. Radionuclide scans may help in the diagnosis of aseptic loosening, infection, complex regional pain syndrome, and periprosthetic stress fractures. These scans are non-specific and may be falsely positive in the first few postoperative years; a technetium bone scan demonstrates increased uptake around 90% of tibial and 65% of femoral components at one year after total knee arthroplasty.[14] The value of radionuclide scans in the diagnosis of infection has been explored with mixed results.[15-17] Technetium bone scans are sensitive but unable to differentiate septic from aseptic failure. Indium111-labeled white-blood-cell scans have value for the exclusion of infection when they are negative, and their specificity is optimal when they are combined with sulfur colloid bone marrow scans to correct for marrow packing in the vicinity of prosthetic components. Positron emission tomography and magnetic resonance imaging may be useful for the diagnosis of infection; however, their utility has not yet been determined. Given the ease, accuracy, and low cost of knee joint aspiration and synovial fluid analysis and culture, advanced imaging should be utilized only for second-line testing—i.e., if no fluid can be obtained with an aspiration or if repeated aspirations lead to equivocal findings.

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Preoperative Laboratory Testing

Every patient who presents with a failure of or pain following, a total knee arthroplasty must be evaluated for a deep periprosthetic infection. Even if the cause of failure seems obvious, concomitant infection may be present and treatment of an infection-related failure of a total knee arthroplasty is fundamentally different from the treatment of aseptic failure. The patient's medical history and the history surrounding the index arthroplasty may suggest an infection. Patient-related risk factors include diabetes mellitus, inflammatory arthritis, obesity, a history of septic arthritis of the native knee, skin disorders, prior ipsilateral knee surgery, revision as opposed to a primary procedure, malnourishment, renal insufficiency (especially when it requires dialysis), and any immunocompromised state. The patient should be specifically questioned regarding the presence of wound-healing problems immediately following the surgery, the extended use of antibiotics, or a return to the operating room, as the patient may not understand the importance of such events with regard to the present pain symptoms. Lack of pain relief since the operation, particularly if the character of the pain is different from that experienced preoperatively, increases the clinical suspicion of infection, as does a recent systemic illness (particularly if it was associated with bacteremia), which may indicate hematogenous infection. Finally, early loosening of a prosthetic component (within the first two to five years post-operatively) should be considered suspicious for infection.

Basic laboratory testing includes evaluation of the erythrocyte sedimentation rate and C-reactive protein level. These are sensitive tests for identifying infection, and it is unlikely both will yield normal results if there is an infection;[18] thus, they are ideal screening tools for the identification of patients who require additional testing. If either test is abnormal or clinical suspicion remains high, the joint should be aspirated and the aspirated fluid should be sent for Gram stain, culture, and a synovial fluid white blood-cell count and differential. The patient should not receive antibiotics for a minimum of two weeks prior to the aspiration to optimize the culture results.[19] The aspiration should be repeated if clinical suspicion remains high. A synovial fluid white blood-cell count of between 1100 and 3000 cell/mm^3 from the site of a total joint arthroplasty is strongly suggestive of an infection.[20-22] This is much lower than the 50,000 to 100,000 cells/mm^3 range that suggests an infection in a native knee. The percentage of neutrophils in the aspirated fluid is also an accurate predictor of infection. If the percentage of neutrophils is between 60% and 80%, infection is likely. When the white blood-cell count is <1100 cells/mm^3 and the percentage of neutrophils is <64%, the negative predictive value is 98.2%; on the other hand, when both are greater than these values the positive predictive value for infection is 98.6%.[23] Determining the white blood-cell count in aspirated fluid has a low cost, is objective, can be performed preoperatively or intraoperatively, and is available to surgeons worldwide.

Preoperative Planning

The surgeon should thoroughly review the radiographs, while remembering that the degree of bone loss surrounding the components is underestimated on the basis of plane radiographs.[24] The function of the extensor mechanism should be ascertained prior to surgery. A preoperative extension lag may be due to relative shortening of the lower extremity secondary to component loosening or catastrophic bearing failure and a subsequent loss of resting tension. This type of extension lag can improve with revision surgery. Conversely, chronic quadriceps or patellar tendon dysfunction may require augmentation with an extensor mechanism or Achilles tendon allograft at the time of the surgery. The surgeon should assess the appropriate height of the joint line to improve the kinematics of the knee. Radiographs available from before the index arthroplasty or radiographs of the native contralateral knee help to determine the anatomic location of the joint line and the amount of posterior femoral offset in a given patient. Patella baja is frequently encountered during revision surgery and may be a result of an intrinsic contracture of the patellar tendon.

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Not infrequently, distal femoral augmentation is required in revision surgery to avoid excessive elevation of the joint line. The joint line can be approximated on the basis of the fibular head, the femoral epicondyles, or the superior pole of the patella in relation to the superior aspect of the trochlear groove. Isolated patellar revision[25] or tibial polyethylene exchange[26] is rarely indicated as they do not usually address the underlying failure mechanism, which is often component malposition. The indications for arthroscopy for a patient with pain related to a total knee arthroplasty are also very limited. Some authors have reported successful arthroscopic lysis of adhesions for the treatment of arthrofibrosis,[27] and others have reported successful arthroscopic debridement in cases of soft-tissue impingement, such as patellar clunk[28] or popliteus tendon impingement.[29]

Illustrative Case

A 70-year-old lady initially diagnosed with right knee degenerative medial compartment osteoarthritis and was treated with a unicondylar knee replacement in June 2000. However, during the course of her recovery, she had persistent pain and was converted to a total knee replacement 5 months later **(Figure 4.1)**.

She had a relatively satisfactory result from a knee replacement. Unfortunately, she sustained a fall in 2003, which led to failure of her medial collateral ligament. Conservative measures were initially employed. She was seen by several specialists for further opinions, and eventually underwent a revision total knee replacement using rotating platform hinged prosthesis in 2014 **(Figure 4.2)**.

Again, she had a relatively unremarkable recovery when she tripped and sustained a quadriceps rupture two months after surgery. A quadriceps repair was urgently performed.

Although she had a good initial recovery, she began experiencing on and off pain, which she initially attributed to the multiple surgeries. She had some degree of persistent pain through years and was lost to follow up with her orthopedic surgeon due to her remote location. She would see a local medical officer, who indicated to her that the pain is to be expected.

By early 2018, she was complaining of progressing pain in her right knee. She sought consultation with another orthopedic surgeon. At the time of initial consult, there were no constitutional symptoms such as fever and malaise. Her knee had a normal appearance **(Figure 4.3A)** except for the presence of an effusion and some mild limitation of motion. Follow-up radiograph after a month showed lucency in proximal tibial **(Figure 4.3B)** and patellar maltracking **(Figure 4.3C)**.

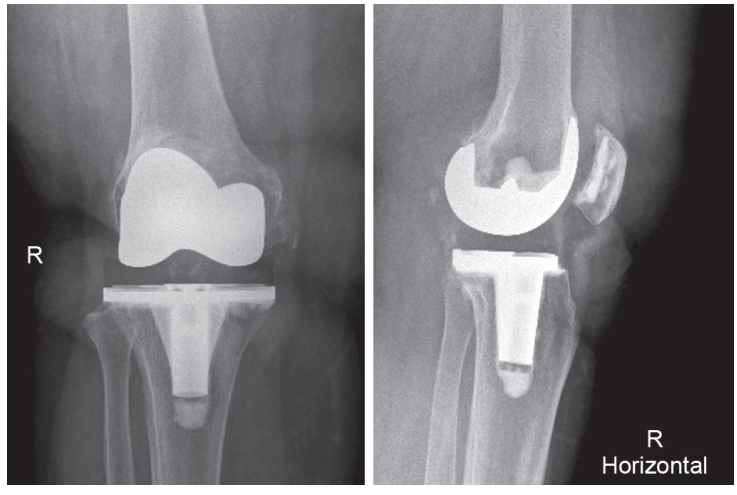


Figure 4.1: Radiograph following conversion of unicondylar knee arthroplasty to total knee arthroplasty

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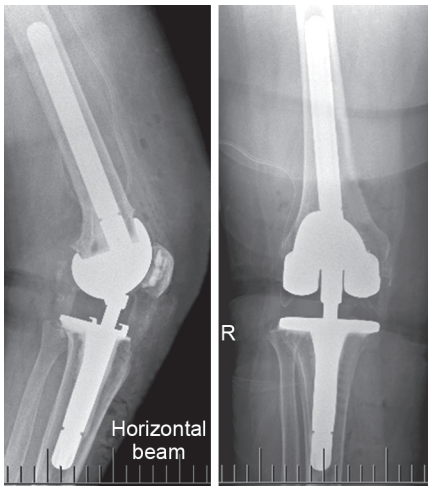


Figure 4.2: Postoperative radiograph following revision with a hinged knee prosthesis for medial collateral ligament injury



Figure 4.3A: Follow-up radiograph showing revision TKA prosthesis *in situ*. The patient had no constitutional symptoms at this time

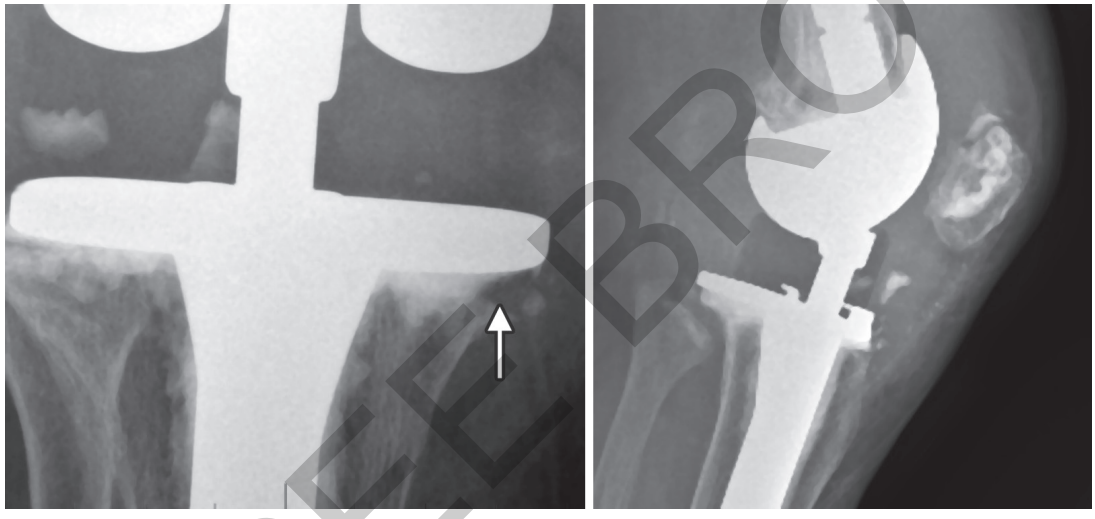


Figure 4.3B: Further follow-up showing lucency (arrow) in the proximal tibia

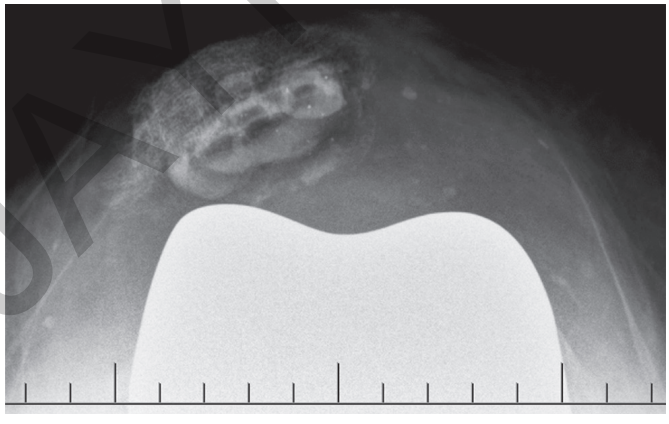


Figure 4.3C: Skyline view showing maltracked patella

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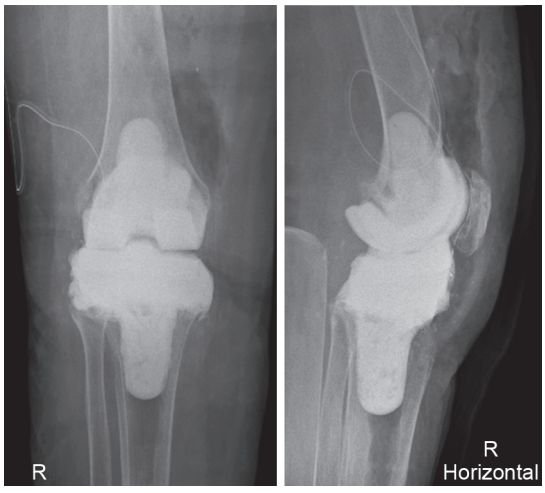


Figure 4.4A: Radiograph showing antibiotic impregnated cement spacer *in situ* following first stage revision knee arthroplasty for infection TKA

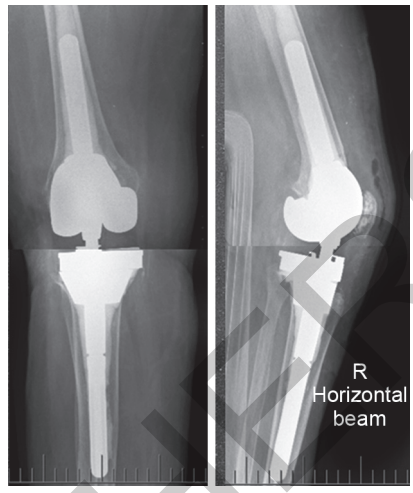


Figure 4.4B: Postoperative radiograph following second stage revision knee arthroplasty

She was initially diagnosed to have implant loosening and extensor failure. As revision surgery was being considered, blood tests and a bone scan were arranged. Interestingly, inflammatory markers were elevated with an ESR value of 70 mm/hr and CRP of 211 mg/L. Further to this, the bone scan demonstrated an increased uptake even in the blood pool phase, whereby an infection could not be excluded.

A further WBC labelled scan was arranged, which demonstrated findings consistent with sepsis. An aspiration of the joint fluid was undertaken. Microscopy showed a WBC count of 27,207 with a 95% neutrophil count. Cultures revealed growth of *Staphylococcus epidermidis*.

She underwent a two-stage revision total knee replacement. During the first stage, a thorough debridement, synovectomy, removal of implants and washout was performed. There were abundant purulent discharge and necrotic tissue in the knee joint. The components were not fully loose. An articulating antibiotic cement spacer was used **(Figure 4.4A)**.

After 8 weeks of culture-guided systemic antibiotics, her second stage was performed. A hinged rotating knee prosthesis was used and metaphyseal fixation was augmented with trabecular metal cones on the distal femur and proximal tibia **(Figure 4.4B)**. A stable knee with a satisfactory range of motion was achieved with. Although there were clinically no signs of active infection, the treating surgeon, with consultation with an infectious disease consultant, opted to maintain on life-long suppressive oral antibiotics in consideration of potentially a long standing latent infection and in consideration of the patients age (currently 88 years old) and remote location of residence.

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Mastering Orthopedic Techniques

REVISION KNEE ARTHROPLASTY

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The finite lifespan of even the most evolved contemporary knee implant designs and knee replacement in increasingly younger patients conspire to evolve the inevitable scenario where the patient outlives the implant. Knee replacements today fail for the reasons different from those, which prevailed a decade ago, but the numbers of failed knee arthroplasties continue to rise due to the burgeoning number of knee arthroplasties performed across the globe. Reconstruction of failed knee arthroplasty presents complex challenge to the surgeon. Soft tissue coverage in the face of severely scarred skin in multiply operated patients, the at risk extensor mechanism and management of bone loss remain key challenges when revising failed total knee arthroplasty (TKA). This book brings together the collective wisdom of the most knowledgeable and experienced surgeons who have seen it all, done it all. The skill, ingenuity and lucid thinking will guide to decision-making with tips to provide the reader enhanced surgical technique. In sync with earlier volumes of the series, the reader will find Revision Knee Arthroplasty pleasure to read with abundant illustrations and variety of approaches from experts all across the world.

Rajesh Malhotra is the Chief of Jai Prakash Narayan Apex Trauma Center and Head of Orthopedics at the All India Institute of Medical Sciences (AIIMS), New Delhi, India. He is an AIIMSONIAN who has grown with the institute for last over 39 years. After completing graduation in 1984 and Master of Surgery in Orthopedics in 1988, he continued working there in different capacities. His pursuit of academics propelled him to infinitive climax in orthopedics domain and his current position. He is elected President of Indian Orthopaedic Association for the year 2018–19. He revolutionized the field of Revision Joint Replacement and Musculoskeletal banking of cadaveric grafts in India after completing Fellowship in Revision Joint Replacement and Bone Banking in Princess Alexandra Hospital, Australia. He established the first CADAVERIC BONE BANK in India at AIIMS, New Delhi. The new techniques and the applications using allografts have improved the patient care and are published internationally making AIIMS the pioneer center of excellence in revision joint replacement and bone banking. He is a globally renowned surgeon trained in Australia, USA and Germany. His pre-eminence revolves around innovative surgical techniques including total acetabular allograft, proximal femoral allograft, extensor mechanism allograft using his original technique recognized globally, cup-cage construct, carpometacarpal arthroplasty, computer-assisted hip and partial knee replacement, BCS knee and the like. His worldwide reckoning as academician is well acclaimed and recognized. He has contributed invited articles to Ortho-hyperguide and Medscape. He is Fellow of Royal College of Physicians and Surgeons, American College of Surgeons, International College of Surgeons, International Medical Sciences Academy, and National Academy of Medical Sciences. He has been recipient of several awards, including BC Roy National Award for Eminent Medical Teacher 2014, AIIMS Excellence Research Award 2016, DMA Medical Excellence Award 2017, Chikitsa Shiromani Puraskar, and KT Dholakia Award for the best paper presentation for Joint Replacement by Dr CS Ranawat in 2006, 2008 and 2014. He is a talented prolific writer, author of over 690 publications including 409 articles, 69 editorials, 41 abstracts, 2 publications in yearbook and 118 posters, a rich source material. He is distinguished editor, with 13 books to his credit and 50 chapters in various books. He has delivered over 650 invited lectures and several orations and keynote addresses.

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