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Case report

Periprosthetic knee infection: two stage revision surgery

Tommaso Bonanzinga[1], Piergiuseppe Tanzi[2], Francesco Iacono[1], Matteo Carlo Ferrari[1], Maurilio Marcacci[3]

[1] Istituto Clinico Humanitas, Rozzano (MI), Italia; [2] Istituto Ortopedico Rizzoli, Bologna, Italia; [3] Istituto Clinico Humanitas, Humanitas University, Rozzano (MI), Italia

Summary. Periprosthetic joint infection (PJI) remains a serious complication following a total joint replacement. Diagnosis and management of PJI is challenging for surgeons since there is no "gold standard". This challenging condition requires a coordinated management approach to achieve good patient outcomes. Further difficulties involve choosing the optimal method to treat the periprosthetic joint infection. In this article, it is stressed the role of the two-stage revision: implant removal, debridement and placement of an antibiotic spacer, and antibiotic therapy with cessation prior to reimplantation. Published literature shows that two stage revision is a valid treatment option for periprosthetic joint infection. (www.actabiomedica.it)

Key words: periprosthetic joint infection, revision, infection, knee, two stage

Infection is a potential complication in any surgical procedure, including total knee replacement. Infection may occur during hospital recovery or after discharge, or many years later. Periprosthetic joint infection (PJI) is one of the most devastating and costly complications following total joint arthroplasty (TJA). PJI is reported to be the cause of failure for 25% (1) of TKA and 15% (2) of THA. Diagnosis and management of PJI is challenging for surgeons since there is no "gold standard" (3). The diagnosis is a combination of signs and symptoms (the first sign is pain and wound secretion; the implant may begin to loose its attachment to the bone), laboratory tests, histological and cultural test. No preferred test for diagnosis of periprosthetic joint infection exists, and the algorithm for the workup of patients suspected of infection remains unclear. A key issue in the treatment of PJI is making the correct diagnosis as early as possible. Because the most common symptom of PJI is nonspecific pain, many tests are used today in an attempt to find the cause of pain. In attempt to guide clinicians in everyday practice, the Musculoskeletal Infection Society (MSIS) has published a new diagnostic approach with two existing major or six minor criteria for diagnosis of PJI. This definition of PJI was recently revised by the International Consensus Group on Periprosthetic Joint Infection. (Table 1). According to the PJI Consensus Group, patients should be considered to have PJI if they meet one of the major criteria or at least three of the minor criteria (Table 2) (5).

According to proposed criteria by MSIS, the new definition of PJI exists when: sinus tract communicating with the prosthesis; positive culture from at least 2 separate tissue or fluid samples ; existence of 4 of the following 6 criteria: elevated serum erythrocyte sedimentation rate (ESR) and serum C-reactive protein (CRP) concentration, elevated synovial white blood cell (WBC) count, elevated synovial neutrophil percentage (PMN%), presence of purulence in the affected joint, isolation of a microorganism in one culture of periprosthetic tissue or fluid, or greater than five neutrophils per high-power field in five high-power fields

Table 1. Definition of periprosthetic joint infection according to International Consensus Group

PJI is present when one of the major criteria exists or three of five minor criteria exist	
Maior criteria:	Two positive periprosthetic cultures with phenotypically identical organism, OR A sinus tract communicating with the joint OR
Minor criteria:	Elevated serum C-reactive AND erythrocyte sedimentation rate Elevated synovial fluid with blood cell (WBC) count OR ++change on leucocyte esterase test strip Elevated synovial fluid polymorphonuclearneutrophil percentage Positive histological analysis of periprosthetic tissue A single positive cultures

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Table 2. The threshold for the minor diagnostic criteria according to the International Consensus Group

Criterion	Acute PJI (<90 days)	Chronic PJI (>90 days)
erythrocyte sedimentation rate (mm/hr)	not helpful, no threshold was determined	30
C-reactive protein (mg/L)	00	10
Synovia white blood cell count (cells/μl)	10.000	3000
Synovial polymorphonuclear percentage (%)	90	80
Leukocyte esterase	+ o ++	+ o ++
Histological analysis tissue	>5 neutrophils per high-power field in 5 high-power fields(x400)	Same as acute

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observed from histologic analysis of periprosthetic tissue at ×400 magnification. PJI may also be present if fewer than four of these criteria are met and clinical suspicion is high (3). In recent years an attempt has been made to identify new tests that can help surgeons to detect patients with real PJI: leukocyte esterase strips and measure of inflammatory biomarkers in the synovial fluid such as alfa defensin (6).

Classification

There are numerous classification systems for PJI. The Tsukayama classification (7) has been used as a rough guide and basis for selection of surgical treatment. It defines an early infection as one that occurs within one month of index arthroplasty and any infection beyond this point as late. Acute hematogenous infection is also included in this classification system.

The Zimmerli/Trampuz classification (8) defines an early infection as one that occurs within 3 months of index surgery. Infections with onset between 3 to 24 months are delayed infections and those occurring >24 months after index arthroplasty are classified as late.

These classification systems are useful because they provide a description for pathogenesis, assumed that early infections are the result of seeding during surgery, whereas late infections are acquired by hematogenous spread.

Another classification proposed by Senneville et al. (9) relies mostly on the duration of symptoms and places less emphasis on the timing of index arthroplasty. Based on this classification, in the acute infections the symptoms onset occur less than one month after surgery and, and any infection with symptoms onset older than one month are considered late.

Less than 4 weeks of symptoms is quite common according to Garvin et al. (10).

The classification proposed by McPherson (11) considers criteria other than timing such as host fac-

tors and microorganism factors, and looks at periods of less than 3 weeks.

Classification of Schafroth M, Zimmerli W (12).

Early infection (<4 weeks) predominantly acquired during implant surgery or the following 2 to 4 days and caused by highly virulent organisms (eg, Staphylococcus aureus or gram-negative bacilli). Leading clinical signs of early infections are persisting local acute joint pain, erythema, oedema, joint effusion, wound healing disturbance, large haematoma, loss of function and fever. Sinus tract and purulent drainage may also develop in some cases. In these case, Irrigation and debridment can be used within 4 weeks of index primary arthroplasty.

Delayed infection (1-24 months) predominantly acquired during implant surgery and caused by less virulent organisms (eg, coagulase-negative staphylococci or Propionibacterium acnes). Persisting or increasing joint pain and early loosening are the hallmarks of a delayed infection, but clinical signs of infection may be absent. Therefore, such infections are often difficult to distinguish from aseptic failure. In these cases I&D can not be used and only one- or two-stage ex-change could be usefull

Late infections (24 months after operation) present either with a sudden onset of systemic symptoms (in about 30%) or as a subacute infection following unrecognized bacteraemia (in about 70%). The most frequent primary (distant) foci of implant-associated infections are skin, respiratory, dental and urinary tract infections.. In these cases I&D can be used with symptoms not longer than 3 weeks.

Treatment

Débridement involves removal of the hematoma, fibrous membranes, sinus tracts, and devitalized bone and soft tissue. One-stage revision includes removal of all foreign material, aggressive débridement, and reimplantation of a new prosthesis during the same procedure. If the pathogen is known preoperatively and the patient has no signs of severe systemic infection, antimicrobial treatment is given for two to three weeks before the prosthesis exchange is performed. In a two-stage exchange, implantation of the new prosthesis is delayed for a variable period of time; an antimicrobial-impregnated spacer can keep the limb at its correct length and allows partial joint mobility.

Two-stage Revision

Stage 1

The first surgery involves implant removal, debridement and placement of an antbiotic spacer.

Safely obtaining adequate exposure at the time of total knee arthroplasty explant is an integral step in successfully performing the procedure. A medial capsular approach combined with an extensive intraarticular synovectomy provides adequate exposure for most patients. If further exposure is required, a quadriceps snip can be used to free the proximal extensor mechanism. If more extensive exposure is required for an excessively stiff or difficult to expose knee, a tibial tubercle osteotomy, V-Y quadricepsplasty or medial epycondilar osteotomy provides wider exposure (13). Sub vastus approach is another effective option to achieve an adequate exposure of joint. During the skin incision the previous scar and the subcutaneous scar tissue must excised. Al the foreign material such as stitches from previous surgeries must be removed. The ideal debridement starts before capsulotomy trying to excise the joint capsule and the synovial tissue in an en-bloc fashion and to delay the joint opening. Once the joint is open aggressive debridement of the remaining capsule and synovial tissue must be performed. Release of the collateral ligaments from their femoral insertion and of the posterior cruciate ligament is recommended to facilitate the exposure of the posterior capsule. An aggressive debridement should be carried on in this region as well avoiding lesions to the posterior neurovascular structures. Fixed implants should be explanted using osteotomes or small power saw blades. All the foreign material must be removed. All the necrotic bone must be removed and the medullar canal must be cleaned carefully from debris and any material from previous surgery. During all the procedure intraoperative samples (5 to 7 for culture, and 3 for histopathology) must be taken from the implant interface, the canal and the surrounding soft tissues.

Once the joint is completely debrided, antibiotic-loaded cement spacer can be implanted (Fig. 1). The choice of the antibiotic should relay on the preoperative culture from synovial fluid aspiration. In order to prevent loosening and displacement in the post-oper-

ative period the spacer should be built in one unique unit and extended in the tibial and femoral canals. The assistant should apply traction to the lower leg in the proper alignment in order to prevent soft tissue laxity. It is important to wash the joint during the exothermic reaction of the cement in order to prevent damage to the posterior neurovascular structures. Prominence of the cement must be avoided to allow easy closure of the arthrotomy with now tension on the skin and other soft tissue. In the post-operative period, an extension brace is suggested to prevent dislocation and a protected weight bearing can be allowed. If the articulated cement spacer the proper size must be evaluated and the proper plastic molds filled with cement. Once the cement is hardened and the plastic removed the cement components must be fixed to the bone with cementation. At this point the surgeon must take into consideration that a poor cementing technique prevents for excessive bone loss during implant removal however it expose to post-operative failure. A compromise should be achieved according to the surgeon experience.

Antibiotic therapy

According to Philadelphia Consensus Meeting on PJI, there is no conclusive evidence regarding the ideal duration of antibiotic therapy. However, a period of antibiotic therapy between 2 to 6 weeks can be recommend. Intravenous (IV) antibiotic therapy for 2-6 weeks followed by 2-6 week of an oral regimen with cessation of antibiotics for 2-8 weeks prior to reimplantation is most employed regimen and has resulted in overall good infection control rates.

Best results are obtained in cases where the pathogen is not resistant and systemic antibiotics are administered simultaneously (25). Commonly prolonged time interval results in suboptimal restoration of patient function and eradication rate, however, in one study, there was no difference in functional outcomes between patients who underwent two-stage exchange procedure with more than 6 month interval between resection and reimplantation and those who had reimplantation within 6 months of resection (14). This

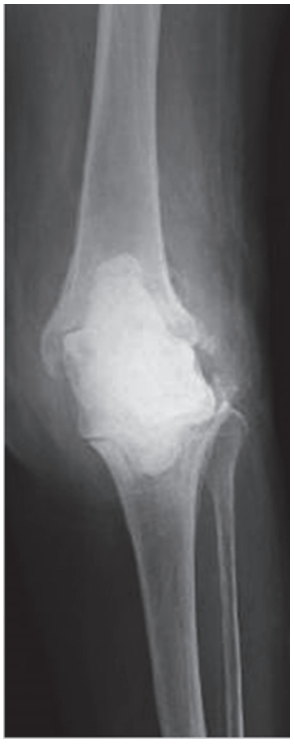

Figure 1. Antibiotic spacer after radical debridement

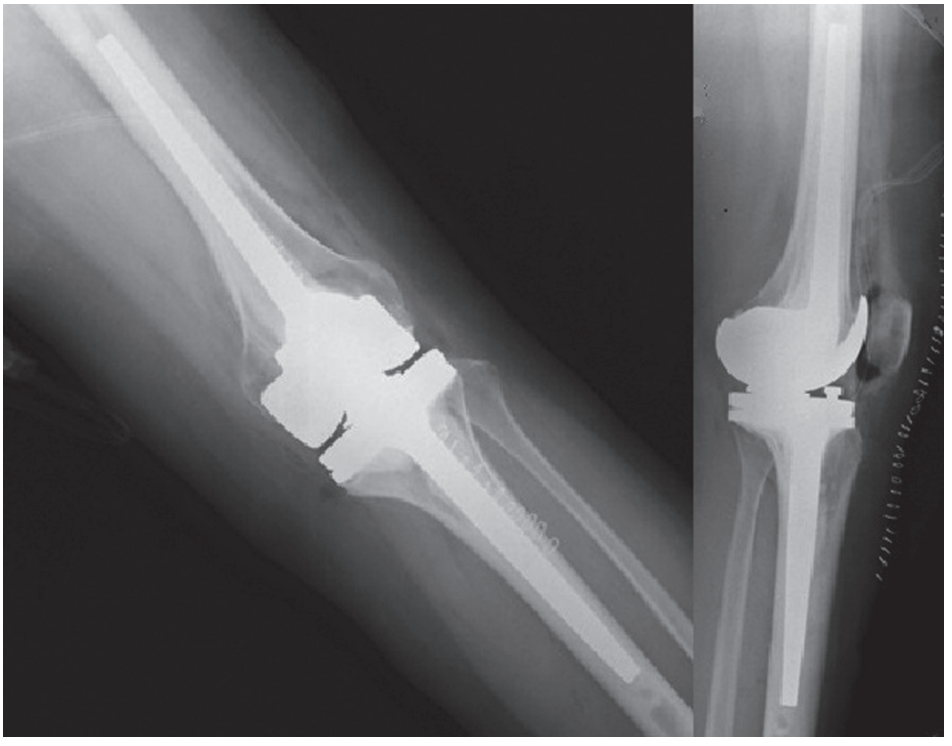

Figure 2. Rotating hinge implant in a two stage revision

interval starts through intravenous antibiotics, usually teicoplanin or vancomycin, until the sensitivity pattern of the culture samples are known, and antibiotics are modified. Patients receive antibiotics for 4-6 weeks following which then antibiotics are stopped for two weeks prior to the second stage to foresee the patient's response. Bernard et al. (27) reported that antibiotic therapy appears able to be limited to a 6-week course, with one week of intravenous administration. Stockley et al. used a non-oral and non-prolonged regimen (2 weeks of IV) after debridement and placement of an antibiotic impregnated cement spacer, with an 87% eradication rate (26).

Aspiration of the joint is useful prior to revision surgery.

Stopping the antibiotics before reimplantation is debated because can induce a regrowth in/of any residual microorganisms. The decision to proceed with prosthesis implantation is determined by clinical evaluation, resolution of blood markers and a negative joint aspirate. Any suspicion of residual infection mandates redoing the first stage with debridement and placement of a new spacer.

Revision

The following revision procedure is similar to any multiple revision setting. The most common issue is the bone defect occurring in the methaphiseal zone. In revision surgery, other difficult issues include bone loss, ligamentous instability, and management of the extensor mechanism. No bone grafts should be use to reconstruct the joint due to higher risk of infection. The soft tissue are more likely to be compromised therefore the authors advocate for the use of a rotating or pure hinge implant in order to prevent ligament instability (Fig. 2). The authors preferred technique include a full cementation of the revision implant in order to provide local antibiotic therapy trough the cement. The choice of the antibiotic should relay on the intraoperative cultures performed during the first stage. If the extensor mechanism is compromised an arthrodesis could be an effective option.

The outcome of any further surgical intervention remains suboptimal, with several studies reporting a failure rate as high as 28% (15-18) and a substantial mortality rate (19). Given the high morbidity and mortality of the initial 2-stage exchange, it is believed that further surgical intervention in these patients has the potential for even worse outcomes and associated complications.

Licterature results

Mortazavi et al (21) reported 72% of rate infection control in 117 patient at a mean follow-up of 45.6 months. Castelli et al (22) reported that two-stage exchange arthroplasty was successful in controlling the infection in 92% of patients. Voleti et al (23) show that reinfection rates was 7% for articulating and 12% for static spacer. A systematic review (38 papers reporting on two-stage revision, n = 1,42) of the results of septic TKA revision published by Romanò et al. (20) reported mean eradication rate of 89.8% for two stage surgery at a mean follow-up of 44.7 months. The average infection eradication rate after a two-stage procedure was higher when an articulating spacer rather than a static spacer was used (91.2% versus 87%). Relying on these studies we can argue that two stage revision is a reasonable treatment option for periprosthetic joint infection.

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Correspondance:
Tommaso Bonanzinga
Istituto Clinico Humanitas,
Rozzano (MI), Italia
E-mail: t.bonanzinga@gmail.com