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Review Article

Current protocols in the management of periprosthetic joint infection: A comprehensive review

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Abstract

Periprosthetic joint infection (PJI) is one of the most challenging complications following joint replacement surgery. The management of PJI involves complex decision-making that requires a multidisciplinary approach, integrating advances in diagnostic techniques, surgical interventions, and antimicrobial therapies. This review provides an in-depth analysis of the current protocols for managing PJI, emphasizing the latest evidence-based strategies for diagnosis, surgical treatment options, antibiotic therapy, and prevention. The review also discusses the emerging trends and future directions in PJI management, aiming to provide healthcare professionals with a comprehensive understanding of the current standards and innovations in this field.

Keywords: Periprosthetic joint infection, Joint replacement, Diagnostic techniques, Surgical treatment, antibiotic therapy, Prevention, Multidisciplinary approach.

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1. Introduction

Periprosthetic joint infection (PJI) remains one of the most severe complications following total joint arthroplasty (TJA), with significant implications for patient outcomes and healthcare resources. The incidence of PJI varies but can happen in as many as 4% of revision surgeries and 1% to 2% of original joint replacements. One effective antibiotic medication, appropriate surgical intervention and early diagnosis are all essential components of a multimodal strategy to managing PJI. The purpose of this review is to give a summary of the procedures currently used in PJI management, emphasizing the most recent developments and difficulties in the area.

2. Diagnostic Protocols for PJI

2.1. Clinical presentation and early detection

Acute septic arthritis with systemic symptoms and persistent, indolent infections with little symptoms are only two examples of the many clinical manifestations of PJI. Since delayed diagnosis is linked to increased morbidity and worse results, early discovery is essential for effective care.[2] Pain, erythema, edema, and drainage from the surgical site are common clinical indicators; however, these symptoms can be difficult to diagnose since they can coexist with other postoperative problems. (**Figure 1**)[3]

2.2. Laboratory investigations

For the first assessment of suspected PJI, laboratory testing is crucial. Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), two nonspecific indicators of inflammation that are extremely sensitive in the PJI, are the most commonly employed assays. Because of its high specificity and sensitivity, synovial fluid analysis—which includes white blood cell count, differential, and alpha-defensin measurement—has emerged as a key diagnostic tool for PJI.[4]

2.3. Microbiological cultures

Sonication fluid, periprosthetic tissue, and synovial fluid microbiological cultures seem to be the gold standard for

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determining the pathogen causing PJI. However, up to 10–20% of individuals may have culture-negative PJI, in which no organism is recovered, which poses a serious diagnostic challenge.[1] Recent innovations like next-generation sequencing (NGS) and multiplex polymerase chain reaction (PCR) present potential substitute for conventional culture techniques, especially in circumstances when the culture is negative.[5]

2.4. Imaging techniques

Imaging studies play a supportive role in diagnosing PJI, with plain radiographs often serving as the initial modality to assess prosthetic loosening, periosteal reaction, or osteolysis. In more complicated cases, positron emission tomography (PET) and magnetic resonance imaging (MRI) scans are being used to determine the degree of infection and direct treatment planning.[6]

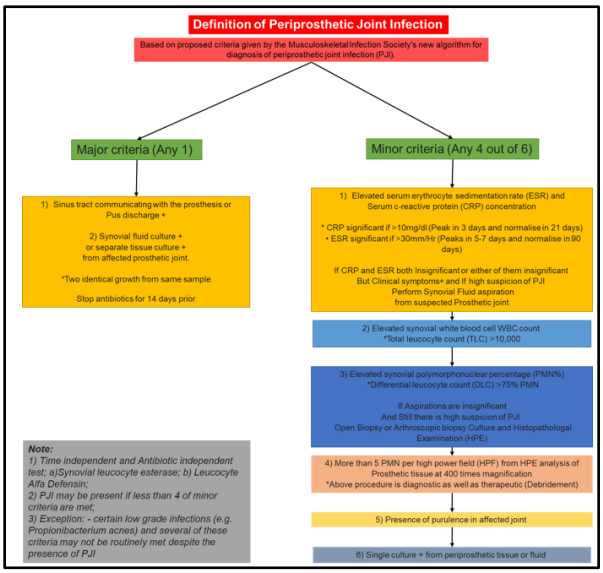

Figure 1: Flowchart of major and minor criteria of per prosthetic joint infection

3. Surgical Management of PJI

3.1. Debridement, antibiotics, and implant retention (DAIR)

The DAIR procedure is an option for early postoperative or acute hematogenous PJI, where the infection is localized, and the prosthesis is well-fixed. This approach involves thorough debridement of infected tissues, retention of the prosthesis, and exchange of modular components, followed by targeted antibiotic therapy.[7] The success of DAIR is contingent on early intervention, typically within four weeks of infection onset.[7]

3.2. One-stage revision surgery

In one-stage revision surgery, sometimes referred to as single-stage exchange, the contaminated prosthesis is removed, all infected tissues are debrided, and a new prosthesis is immediately reinserted. The benefits of this strategy in lowering hospital stays and total treatment costs have made it popular in Europe and are being embraced globally.[8] This strategy can frequently be utilized for patients with well-characterized infections and no notable comorbidities, although patient selection is crucial.[8]

3.3. Two-stage revision surgery

The most effective treatment for chronic PJI is still two-stage revision, especially when patients with serious comorbidities are involved.[9] This method includes a phase of systemic antibiotic therapy after the prosthesis is removed, debrided and a cement spacer laden with antibiotics is placed. Reimplantation of a new prosthesis is the second step once infection control is accomplished.[8] Despite its efficacy, this strategy is linked to more expensive, prolonged, and morbid treatment periods.[8]

3.4. Resection arthroplasty and arthrodesis

Resection arthroplasty, also known as the Girdlestone surgery, or arthrodesis, also known as joint fusion, may be explored in situations when reimplantation is not practical, such as in patients with limited soft tissue covering or recurrent infections. For patients with incurable infections, these choices can save lives and relieve pain, even while they impair joint function.

4. Antibiotic Therapy

4.1. Systemic antibiotic therapy

It is the most important component of PJI management, with treatment regimens tailored to the specific pathogen identified. Empirical antibiotic therapy is typically initiated based on the likely pathogens, such as Staphylococcus aureus or coagulase-negative staphylococci, and adjusted according to culture results.[3] The duration of antibiotic therapy varies depending on the surgical approach and the patient's clinical response but generally ranges from six weeks to several months.[10]

4.2. Local antibiotic delivery

To attain high local concentrations of antibiotics while reducing systemic toxicity, local antibiotic delivery—using antibiotic-loaded bone cement, spacers, or beads—is being used more and more.[11] The use of antibiotic-loaded spacers to preserve joint space and provide antibiotics directly to the infection site makes this method very useful in two-stage revision operations.[8]

4.3. Novel antibiotic strategies

Methicillin-resistant Staphylococcus aureus (MRSA) and other antibiotic-resistant organisms have made it necessary to investigate alternative antibiotic techniques, such as combination therapy, phage therapy, and the creation of new antimicrobial drugs.[5] Potential novel treatment options for resistant PJIs are being explored through ongoing research on the use of bacteriophages and antimicrobial peptides. (**Figure 2**)[7,12]

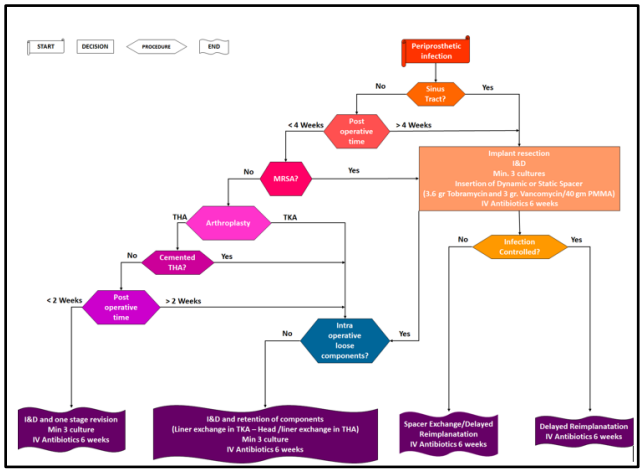

Figure 2: Algorithm utilized for per prosthetic joint infection treatment. THA = total hip arthroplasty, TKA = total knee arthroplasty, I&D= irrigation and debridement, Min. = minimum, IV = intravenous, gr = grams, MRSA = methicillin-resistant Staphylococcus aureus, and PMMA = polymethylmethacrylate

5. Prevention of PJI

5.1. Preoperative optimization

Reducing the incidence of PJI requires optimizing patients prior to surgery, which includes glycemic management, quitting smoking, and treating any infections that may already be present. It has been demonstrated that decolonization procedures, such as the use of mupirocin and chlorhexidine washes, and screening for nasal carriage of Staphylococcus aureus lower the prevalence of PJI.[13]

5.2. Intraoperative strategies

The use of laminar airflow systems, appropriate surgical technique, and the use of prophylactic antibiotics are intraoperative measures to avoid PJI.[14] Cefazolin or cefuroxime are the most often used preventive antibiotics, and their timing and selection are crucial.[15] There is also continuous discussion on the use of antibiotic-loaded bone cement in primary arthroplasty, despite data indicating that high-risk patients may benefit from it.[16]

5.3. Postoperative care

Early detection and treatment of wound complications is crucial to lowering the risk of infection, and postoperative care is crucial in preventing PJI. It has been demonstrated that in high-risk patients, the use of closed-incision negative pressure wound treatment (ciNPT) lowers the frequency of surgical site infections.[17] Furthermore, early mobilization and wound care education for patients are crucial elements of postoperative treatment.[14]

6. Discussion

A major side effect of joint replacement procedures, such as hip or knee arthroplasty, is preprosthetic joint infection (PJI). The functional result of the patient can be greatly impacted by PJI, necessitating early identification and treatment to control the infection and prevent consequences like sepsis or prosthetic joint failure. Microorganisms are introduced during surgery or spread hematogenously (via the circulation) after surgery as part of the pathophysiology of PJI. Common attackers include bacteria such as Enterococci, Streptococcus, and Staphylococcus aureus. Because it shields bacteria from the immune system and medications, the development of a biofilm on the prosthesis' surface contributes significantly to the persistence of infection.

Acute infections commonly appear as redness, warmth, swelling, discomfort, fever, and wound drainage, however PJI symptoms might vary. More subtly, chronic infections may manifest as pain, stiffness, or a progressive decline in joint function. In chronic situations, systemic signs like fever might not be as noticeable. It can be difficult to diagnose PJI; diagnostic tests laboratory testing, clinical examination, C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), blood cultures, joint aspiration, microbiological culture, imaging such as X-rays or MRI scans are necessary and might show indications of prosthesis loosening, fluid accumulations, or bone involvement. When an infection is present, certain inflammatory markers may be increased.

The efficiency of diagnosis and treatment, the pathogen's virulence, and the existence of comorbidities are some of the variables that affect PJI outcomes. Many people can regain their previous level of function if they receive early diagnosis and treatment. However, prolonged healing periods, worse functional results, or in extreme situations, the necessity for amputation, may arise from persistent infections or those require major procedures.

7. Challenges and Future Directions

7.1. Diagnostic challenges

Early and precise diagnosis of PJI is still difficult to achieve despite advancements in diagnostic methods. To increase the accuracy of PJI diagnosis, more sensitive and specific biomarkers must be developed. Additionally, improved imaging and molecular diagnostics must be integrated.[4] Future research should focus on the validation of novel diagnostic tests and the standardization of diagnostic criteria to reduce variability in clinical practice. The incorporation of artificial intelligence (AI) and machine learning algorithms in analyzing complex diagnostic data could also enhance the early detection and accurate diagnosis of PJI, especially in ambiguous or culture-negative cases.[18]

7.2. Antibiotic resistance

The management of PJI is significantly hampered by the developing problem of antibiotic resistance. There is a need for new antimicrobial medicines and combination therapies as a result of the advent of multidrug-resistant pathogens like MRSA and vancomycin-resistant Enterococcus (VRE).

Addressing this dilemma requires ongoing research into the use of antimicrobial peptides, bacteriophage treatment, and new medicines. Furthermore, stewardship initiatives that maximize the use of antibiotics in orthopedic surgery are essential for reducing the emergence of resistance.[5]

7.3. Surgical challenges

Surgical management of PJI continues to evolve, but challenges remain, particularly in complex cases involving massive bone loss, soft tissue defects, or recurrent infections. Advances in surgical techniques, such as 3D-printed custom implants and computer-assisted surgery, are being explored to improve outcomes in these challenging cases. Additionally, the development of biodegradable antibiotic carriers and bioactive implants that promote osseointegration while preventing infection recurrence represents an exciting area of research.[9]

7.4. Patient-centered care

Although surgical management of PJI is still developing, there are difficulties, especially in complicated patients with significant bone loss, soft tissue abnormalities, or recurring infections. To enhance results in these difficult instances, new surgical procedures are being investigated, such as computer-assisted surgery and 3D-printed bespoke implants. Furthermore, an intriguing field of study is the creation of bioactive implants and biodegradable antibiotic carriers that encourage osseointegration and stop infection recurrence. [14]

7.5. Innovations in prevention

It is crucial to prevent PJI, and new methods are always being created. To lower the incidence of PJI, innovations including antimicrobial-coated implants, perioperative immunomodulation, and the use of nanotechnology in wound dressings are being researched.[1]

8. Conclusion

Per prosthetic joint infection remains one of the most challenging complications in orthopedic surgery, requiring a comprehensive and multidisciplinary approach to management. The current protocols for managing PJI have evolved significantly, with advancements in diagnostic techniques, surgical interventions, and antibiotic therapies contributing to improved outcomes. However, challenges such as antibiotic resistance, diagnostic accuracy, and surgical complexity continue to pose significant obstacles.

Future directions in PJI management include the development of more precise diagnostic tools, innovative surgical techniques, and new antimicrobial strategies. Additionally, a greater emphasis on prevention, patient-centered care, and personalized medicine will be critical in addressing the ongoing challenges associated with PJI. As research continues to advance, the integration of these innovations into clinical practice will be essential for improving patient outcomes and reducing the burden of PJI on the healthcare system.

9. Source of Funding

None.

10. Conflict of Interest

None.

References

1. Aboltins C, Daffy J, Choong P, Stanley P. “Current concepts in the management of prosthetic joint infection. *Inter Med J,* 2014; 44(9):834-40.
2. Gazendam A, Wood TJ, Tushinski D, Bali K. “Diagnosing periprosthetic joint infection: A scoping review. *Curr Rev Musculoskel Med*, 2022;15(3):219-29.
3. Tripathi S, Tarabichi S, Parvizi J, Rajgopal A. “Current relevance of biomarkers in diagnosis of periprosthetic joint infection: an update”. *Arthroplasty*, 2023;5(1):41-8.
4. Portillo ME, Sancho I. “Advances in the microbiological diagnosis of prosthetic joint infections”. *Diagnostics,* 2023;13(4):800-9.
5. Ricciardi BF, Muthukrishnan G, Masters EA, Kaplan N, Daiss JL, Schwarz EM. “New developments and future challenges in prevention, diagnosis, and treatment of prosthetic joint infection”. *J Orthop Res*, 2020;38(7):1423-35.
6. Otto-Lambertz C, Yagdiran A, Wallscheid F, Eysel P, Jung N. “Periprosthetic infection in joint replacement: diagnosis and treatment”. Deutsches Ärzteblatt Int, 2017;114(20):347.
7. Vaz K, Scarborough M, Bottomley N, Kendrick B, Taylor A, Price A, Jackson W. “Debridement, antibiotics and implant retention (DAIR) for the management of knee prosthetic joint infection”. *The Knee,* 2020; 27(6):2013-5.
8. Belay ES, Danilkowicz R, Bullock G, Wall K, Garrigues GE. “Single-stage versus two-stage revision for shoulder periprosthetic joint infection: a systematic review and meta-analysis”. *J Shoul Elbow Surg.* 2020;29(12):2476-86.
9. Kapadia BH, Berg RA, Daley JA, Fritz J, Bhave A, Mont MA. “Periprosthetic joint infection”. *Lancet*. 2016;387(10016):386-94.
10. Steadman W, Chapman PR, Schuetz M, Schmutz B, Trampuz A, Tetsworth K. “Local antibiotic delivery options in prosthetic joint infection. *Antibiotics*. 2023;12(4):752.
11. Siljander MP, Sobh AH, Baker KC, Baker EA, Kaplan LM. “Multidrug-resistant organisms in the setting of periprosthetic joint infection-diagnosis, prevention, and treatment”. *J Arthrop*. 2018;33(1):185-94.
12. Rao N, Cannella BA, Crossett LS, Yates Jr AJ, McGough Iii RL, Hamilton CW. “Preoperative screening/decolonization for Staphylococcus aureus to prevent orthopedic surgical site infection: prospective cohort study with 2-year follow-up”. *J Arthroplasty*. 2011;26(8):1501-7.
13. Alijanipour P, Heller S, Parvizi J. “Prevention of periprosthetic joint infection: what are the effective strategies?”. *J Knee Surg.* 2014;27(04):251-8.
14. Chen AF, Parvizi J. “Antibiotic-loaded bone cement and periprosthetic joint infection”. *J Long-term effects Med Imp*. 2014;24(2-3).
15. Semsarzadeh NN, Tadisina KK, Maddox J, Chopra K, Singh DP. Closed incision negative-pressure therapy is associated with decreased surgical-site infections: a meta-analysis. *Plastic Reconst Surg*. 2015;136(3):592-602.
16. Klemt C, Yeo I, Harvey M, Burns JC, Melnic C, Uzosike AC, Kwon YM. “The use of artificial intelligence for the prediction of periprosthetic joint infection following aseptic revision total knee arthroplasty. *J Knee Surge.* 2024;37(2):158-66.
17. Le Vavasseur B, Zeller V. Antibiotic therapy for prosthetic joint infections: an overview”. *Antibiotics*. 2022;11(4):486.

18. Bosco JA, Bookman J, Slover J, Edusei E, Levine B. “Principles of antibiotic prophylaxis in total joint arthroplasty: current concepts”. *JAAOS-JAm Acad Orthop Surg*. 2015;23(8):27-35.

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