Journal of Orthopedics and Orthopedic Surgery

Commentary Open Access

Commentary: Debridement, antibiotics and implant retention (DAIR) for the management of knee prosthetic joint infection

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Article Info

Article Notes
Received: November 10, 2020
Accepted: December 21, 2020

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Keywords:
Prosthetic joint infection
Debridement
Antibiotics and implant retention
Revision
Total knee replacement

Introduction

Prosthetic joint infection (PJI) is a devastating complication following knee replacement, and accounts for 0.92 (0.90-0.94) revisions per 1000 patient-years[1]. Recent literature has suggested that infection eradication rates may be similar between one- and two-stage procedures[2]. However, staged treatment is cost-intensive, carries significant morbidity and mortality and may be considered "overtreatment" in some cases[2]. As a result, focus has renewed on single-stage revision. However, the role of debridement, antibiotics and implant retention (DAIR) procedures have been given comparatively less attention. The main purpose of "Debridement, antibiotics and implant retention (DAIR) for the management of knee prosthetic joint infection"[3] was to describe the indications for this procedure and an appropriate surgical technique. This commentary will provide a rapid review of the most important aspects of this article with reference to the literature and our own practice.

Diagnosis of PJI

The British Orthopaedic Association (BOA) and British Association for Surgeons of the Knee (BASK) have recently produced a document outlining best practices for the investigation and management of PJI after knee replacement[4]. This advocates methods to standardise diagnosis, including use of a named clinical prediction rule, such as the International Consensus Meeting (ICM) 2013 criteria[5]. The document also lists strategies to improve the diagnostic value of microbiological sampling. Perhaps most important is the recommendation that patients are antibiotic-free for a minimum of two weeks prior to sampling, unless the patient is acutely unwell and these cannot safely be omitted. For joint aspirates, samples should be inoculated into blood culture bottles to improve culture yield, and facilities should be available to report synovial fluid leukocyte counts and granulocyte percentage to improve the interpretation of results. Bedside testing using additional markers, such as leukocyte esterase, can also be considered; however, clear benefit for combining diagnostic tests is yet to be demonstrated[6]. Tissue samples should also be obtained. In cases of chronic PJI, this may be prior to revision surgery – through biopsy either in the operating theatre or interventional radiology suite. We have a low threshold for re-sampling in patients with negative initial cultures and high suspicion of PJI. This includes additional testing, such as extended culture techniques or polymerase-chain reaction (PCR) assays. More commonly in acute PJI, tissue samples are obtained

at the time of DAIR or revision surgery. Our practice is to obtain five surgical specimens from different anatomical locations within the knee using a non-touch technique and clean instruments for each sample. The recommendation for five (or six) microbiological samples originates from the Oxford Skeletal Infection Research and Intervention Service (OSIRIS) Collaborative, who used a simple mathematical model to evaluate the diagnostic performance of different numbers of samples[7]. The precise locations for sampling are decided intraoperatively, guided by the principles of sampling macroscopically abnormal tissue, providing coverage of wide area of the knee and preferentially sampling tissue in contact with the material and joint fluid[8]. We typically obtain samples from the bone-implant interface, suprapatellar pouch and medial and lateral gutters. The recent study by Bémer et al. reported that the rate of sample positivity showed little variation with type of tissue[8]. We send samples for both microbiological and histological analysis. Histological analysis is useful in cases of culture-negative PJI. Diagnosis is typically made using Feldman's histological criteria of at least 5 neutrophils per high-power field over five separate microscopic fields[9]. Radiological investigations in PJI include mandatory plain radiographs to investigate for septic loosening and to check implant alignment. Specialised nuclear medicine tests are not useful in acute PJI, but may be in chronic cases. The assimilation of multiple test results is best achieved in an Infection Multidiscipinary Team (MDT) meeting involving surgeons, microbiologists, radiologists and specialist nurses.

Indications for DAIR

DAIR should be considered as a treatment option for acute PJI, whether in the setting of recent surgery or haematogenous spread. Early-acute PJI has been defined as less than 3 weeks of infective symptoms, in patients within 3 months of index surgery; whilst late-acute PJI has been defined as new infective symptoms more than 3 months from index surgery in a previously asymptomatic joint replacement[10]. Whilst previous guidelines have recommended against DAIR after four weeks[11], newer evidence suggests that the duration of symptoms may be more important[12].

The pre-requisites for DAIR include a well-functioning knee that is not loose, unstable or misaligned[4]. Further contraindications are the presence of a sinus tract, the inability to achieve adequate wound coverage and infections caused by difficult-to-treat organisms (such as fungi or multi-drug resistant species). There is currently no agreement on the optimal timing of surgery for 'leaky' wounds. However, the LEAK study is a prospective, national RCT investigating early DAIR versus non-operative management for patients with persistent wound leakage at post-operative day 9 or 10 [13].

Surgical technique

Simple, open or arthroscopic washout procedures should be viewed as temporising only and reserved for acutely unwell patients who would not tolerate a formal DAIR or revision procedure. Our recent article provided a detailed operative technique and emphasised the importance of involvement of an experienced arthroplasty surgeon[3]. The key considerations were to provide an accurate microbiological diagnosis, to maximise reduction of the burden of infection and to be able to convert to a one- or two-stage revision procedure if necessary. To improve the success of infection clearance, it is essential that surgeons are competent to perform an extensile approach and to thoroughly debride the joint. All modular components should be exchanged, and this facilitates access to the posterior knee. DAIR procedures should be allocated appropriate time on an operating list. This should account for the time required for meticulous debridement, lavage with at least 8 litres of fluid, and the need for the surgeon to re-scrub, re-prep and re-drape, and for clean instruments to be opened.

It is important to review the described surgical technique in the context of the available evidence:

Microbiological sampling using a non-touch technique with clean instruments

We consider this to be a pragmatic approach designed to minimise contamination. Whilst there is limited evidence to support this practice, this is possibly an area where theory alone provides sufficient support.

Postponement of prophylactic antibiotics until after microbiological sampling

This recommendation is likely to engender more debate. A recent systematic review by Wouthuyzen-Bakker et al.[14] found that antibiotic administration at induction did reduce culture yield for a minority of patients. However, the conclusion of their review was to recommend against this practice on the basis that rates of surgical site infection (SSI) may increase. It is important to note that investigation of SSI rates was not a focus of their review. Instead, this conclusion was based on a single retrospective cohort study from their centre[15]. This showed that earlier surgeries (from 2007-2010) had higher rates of SSI than later surgeries (from 2010-2013), which they attributed to the timing of prophylactic antibiotic administration.

Where possible, the choice of antibiotic therapy is tailored to the susceptibility of the infecting organism. For empiric therapy, our unit favours intravenous meropenem and vancomycin since it has been shown to provide effective coverage for a broad spectrum of organisms[16]. These antibiotics are continued post-operatively under

the stewardship of our Bone Infection Unit. Meropenem is usually discontinued at 48 hours, provided that gram-negative organisms have not been cultured. Vancomycin is continued until final culture results are available.

Volume and choice of lavage fluid and use of local bio-absorbable antibiotics

The Second International Consensus Meeting on Musculoskeletal Infections did not identify any studies which addressed the question of volume of fluid for lavage in DAIR[17]. However, there was a super majority, strong consensus for lavage with 6-9 litres of fluid. Future studies are required to evaluate the use of lavage agents which disrupt biofilm and the efficacy of local bio-absorbable antibiotics as an adjunct.

Post-operative management

All patients should be enrolled in an Infection MDT to plan appropriate post-operative antimicrobial treatment and to monitor response. Patients should be counselled to expect antibiotic treatment for a period of three to six months in most cases. This typically involves initial broad-spectrum intravenous antibiotics, followed by a more targeted regimen of usually oral antibiotics based on final culture results. The duration of antibiotic administration may decrease in the future, but the current evidence-base is limited. The Second International Consensus Meeting on Musculoskeletal Infections, concluded that the optimal duration of antibiotics was unknown, but a minimum of six weeks treatment was indicated[17].

Outcomes following DAIR

In our practice, even with protocolised treatment as above, our local data suggests failure rates of 20-30% (unpublished work). Several series have demonstrated the importance of adequate debridement[18] and the ability to achieve acceptable clinical outcomes following DAIR[19]. Wouthuyzen-Bakker et al.[10] recently reported success rates of 76% for DAIR in early-acute PJI compared to 46% for late-acute PJI. The same pattern was identified by Zhu et al.[20]. Both studies identified that Staphylococcus aureus infection was a risk factor for failure of late-acute DAIR. In addition, the CRIME-80 score may be useful to predict failure for late acute infections[22]. For acute post surgery PJI, the KLIC score (Kidney, Liver, Index surgery, Cemented prosthesis and C-reactive protein value) may instead be used[21]. It is also of note that DAIR procedures destined to fail re-present early, with 90% of cases declaring themselves within the first year[10].

There are currently no registry reports on the outcomes following DAIR. The National Joint Registry (NJR) for England, Wales, Northern Ireland and the Isle of Man have previously grouped DAIR procedures with single-stage revisions in their reports[1]. However, their latest data collection forms will allow these procedures to be analysed separately in the future. Few studies have evaluated patient reported outcome measures (PROMs) following DAIR procedures. However, there is emerging evidence from our unit that successful DAIR can produced similar functional outcomes to uncomplicated knee arthroplasty[23].

Conclusions

Acceptable clinical outcomes and infection eradication can be achieved with DAIR procedures in the context of appropriate pre-operative planning, surgical technique and multidisciplinary team follow-up.

Declaration of interest

One or more authors have received Speakers Bureau fees from Zimmer Biomet and DePuy Synthes. Neither company had any role in the design, conduct or reporting of this study.

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