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Review Paper
TMJ Disorders

Temporomandibular joint replacement periprosthetic joint infections: a review of early diagnostic testing options

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Abstract. The incidence of a periprosthetic joint infection is uncommon after total joint replacement. Since the clinical, psychological, and economic consequences of this complication are substantial, the development of management algorithms based on early diagnostic testing has been the subject of continued exploration in the orthopaedic literature. While there has been discussion of this topic in the total temporomandibular joint replacement literature and preliminary management algorithms have been established, no diagnostic testing protocols have been proposed or studied for the management of early and/or late periprosthetic joint infections. This paper will review the classification of periprosthetic joint infections, the associated risk factors, the clinical sensitivity and specificity of laboratory and imaging diagnostic studies and their utility in the management of early and late onset orthopaedic periprosthetic joint infections. This review may provide an initial framework for the use of early diagnostic testing for the management of total temporomandibular joint replacement periprosthetic joint infections and stimulate further investigation into this topic.

Key words: temporomandibular joint replacement; periprosthetic joint infections.

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The Medicare 5% national sample administrative database documents a 1.63% and 1.55% risk of infection within the first 2 years following primary total hip (THA) and knee arthroplasty (TKA), with an additional risk between 2 and 10 years of 0.59% and 0.46%, respectively.[1,2] Further studies have suggested that both the incidence and prevalence of periprosthetic joint infection (PJI) are increasing with time, with the overall infection burden expected to rise to >6% in coming years.[3]

Despite these statistics revealing the incidence of PJI after total joint replacement (TJR) to be uncommon, the clinical, psychological, and economic consequences of this complication can be substantial. Therefore, the development of management algorithms based on early diagnostic testing has been the subject of continued exploration in the orthopaedic literature.

A retrospective survey of 2476 temporomandibular joint total alloplastic joint replacement (TMJ TJR) cases involving 3368 joints, reported 51 (1.51%) PJI cases occurring in that cohort over a mean of 6 months postoperatively (range 2 weeks to 12 years).[4]

While there has been discussion of this topic in the TMJ TJR literature and preliminary management algorithms have been presented,[4–6] no diagnostic testing protocols have been proposed or studied for the management of early and/or late PJIs.

This paper will review the classification of PJIs, the associated risk factors, the clinical sensitivity and specificity of laboratory and imaging diagnostic studies and their utility in the management of early and late onset orthopaedic PJIs. This review may provide an initial framework for the use and study of early diagnostic testing for the management of TMJ TJR PJI.

Periprosthetic joint infection

Definition of PJI

Both the orthopaedic community and the Centers for Disease Control and Prevention (CDC) have been frustrated by the lack of a standard definition for PJI. Interpretation of the available literature has become increasingly difficult because centres and investigators use different, and at times conflicting, definitions for PJI. Therefore, in 2011, a Musculoskeletal Infection Society (MSIS) workgroup evaluated the available literature and proposed a definition for PJI that could be adopted universally (Table 1).[7]

PJIs present characteristic signs that can be divided into acute manifestations (severe pain, high fever, toxaemia, heat, rubor, and surgical wound discharge) and chronic manifestations (progressive pain, skin fistulae, and drainage of purulent secretions, without fever). The clinical presentation depends on the virulence of the etiological organism, the nature of the infected tissue, the route of acquisition of the infection, and the duration of disease evolution.[8]

Classification of PJI

The classification system most widely used today in orthopaedics is the one proposed by Fitzgerald Jr. et al.[9] This classification defines the time at which contamination occurs, establishes the likely etiological agent involved, and the best management strategy (Table 2).

Early and delayed infections are thought to be due to organisms introduced at the time of surgery, whereas late infections are more likely to have a hematogenous aetiology. Infecting organisms form microcolonies on the prosthesis surface, and these elaborate exopolysaccharides that coalesce, forming a biofilm. Once formed, organisms within the biofilm are protected from host immune responses and may display reduced susceptibility to antibiotics as a result of changes in metabolic processes and poor diffusion.[10]

Table 1. Musculoskeletal Infection Society (MSIS) workgroup definition for periprosthetic joint infection.

1. Presence of a sinus tract communicating with the prosthesis
2. A pathogen isolated by culture from two or more separate tissue or fluid samples obtained from the affected prosthetic joint
3. Four of the following six criteria:
Elevation of serum erythrocyte sedimentation rate and serum C-reactive protein concentration
Elevated synovial white blood cell count
Elevated synovial polymorphonuclear percentage
Presence of purulence in the affected joint
Isolation of a microorganism in one culture of periprosthetic tissue or fluid
More than five neutrophils per high-power field in five high-power fields observed in a sample for histological analysis of periprosthetic tissue at ×400 magnification

Table 2. Classification of orthopaedic periprosthetic joint infections.

1. Acute postoperative infections occurring within 3 months of surgery
The etiological agents are generally of hospital origin, especially *Staphylococcus aureus* and *Staphylococcus epidermidis*
2. Late deep infections that appear between 3 months and 2 years after surgery
The etiological agents are considered to be of nosocomial origin, since the contamination probably occurred during prosthesis implantation, and generally consist of bacteria from the normal skin flora, such as *S. epidermidis*
3. Late haematological infections that occur more than 2 years after surgery
The etiological agents are of community origin and are determined by the apparent source of bacteria: anaerobic bacteria, while cellulitis and skin abscesses are associated with *S. aureus* or streptococci or enterobacteria originating from the gastrointestinal and genitourinary tracts. Dental infections are associated with bacteremia due to viridans streptococci

Risk factors

Patient, surgical, and postoperative related risk factors in orthopaedic PJI have been spelled out and must be considered[11–19] (Table 3).

Diagnostic testing

To date there is no diagnostic test with absolute accuracy, and due to this lack of a 'gold standard' for the diagnosis of PJI, diverse and sometimes conflicting criteria have been proposed (Table 4).

Serology

The erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) level provide excellent diagnostic information for establishing the presence or absence of infection before surgical intervention in patients with pain at the site of a TJR.

ESR values higher than 30 mm/h have been associated with deep infection.[7] However, the ESR is not always elevated in a chronic deep infection. When the ESR is used alone, its specificity and sensitivity reach 0.82 and 0.86, respectively.[20]

The CRP level usually peaks on postoperative day 2 after TJR and then falls back to normal levels in 2–3 weeks. CRP is usually normal in cases of aseptic loosening, but is elevated by more than 10 mg/l in cases of infection.[21]

When used in conjunction with ESR, the CRP level has a specificity of 1.00 for diagnosing PJI.[7,21] Repeated measurements

Table 3. Patient, surgical, and postoperative related risk factors in orthopaedic periprosthetic joint infections.

A. Patient-related risk factors for infection include:
1. Previous revision arthroplasty or previous infection associated with a prosthetic joint at the same site
2. Tobacco abuse
3. Obesity
4. Rheumatoid arthritis
5. Concurrent neoplasm
6. Immunosuppression and diabetes mellitus
B. Surgical-related risk factors include:
1. Simultaneous bilateral arthroplasty
2. Operative time longer than 160 min
3. Allogeneic blood transfusion
C. Postoperative-related risk factors include:
1. Wound healing complications (e.g., superficial infection, haematoma, delayed healing, wound necrosis, and dehiscence)
2. Atrial fibrillation, myocardial infarction, urinary tract infection
3. Prolonged hospital stay
4. *Staphylococcus aureus* bacteremia