Prevention, Diagnosis, and Treatment of Implant Infection in the Distal Upper Extremity

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Implant related infection is relatively unusual in surgery to the hand and distal upper limb. When such infections occur, the consequences can be devastating. We review the latest guidance and research on the prevention, diagnosis, and management of implant-associated infections in the hand and distal upper limb. *(J Hand Surg Am. 2018;43(1):68–74.* *Copyright © 2018 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Hand, upper limb, infection, arthroplasty, implant.

The use of implanted material in hand and upper limb surgery has increased relentlessly. One of the greatest challenges facing surgeons who utilize these materials is the specter of infection. The majority of the literature pertaining to periprosthetic infection is based upon experience from lower limb arthroplasty. As a consequence, there is scant information in the literature to guide the management of implant-associated infection in the distal upper limb.

Presentation of prosthetic joint infection (PJI) has been described as trimodal, with distinct clinical features attributable to early, late, and delayed presentation.[1] The Coventry Classification of Arthroplasty Infection following total hip arthroplasty is summarized in Figure 1. In the hand and upper limb, presentation may be more insidious with fewer systemic symptoms.

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INCIDENCE

The overall incidence of PJI in the hand is less well understood than for larger joints. In hip or shoulder surgery, the rate stands at around 1% whereas that after knee surgery is 2%.[2] Small series in the hand of around 50 joints have reported rates of infection of between 3 and 4%.[3] The hand has a robust blood supply with a rich anastomosis. The approach required for an upper limb joint replacement is arguably less traumatic than for replacements in the lower limb. The difference in incidence may, therefore, be related to our position on the learning curve for the procedures or the microbiology in the hand environment.

BIOFILMS

Infection on surgical implants occurs as a biofilm—a sessile, organized community of bacterial cells with altered physiology and impaired susceptibility to antibiotics.

As the implant enters the body, it becomes coated in a conditioning film of plasma proteins.[4] The conditioning film on the implant surface displays a variety of proteins including collagen, fibrinogen, and fibronectin. Bacteria colonizing the implant, in the majority of cases, will interact with this human protein film rather than with the implant surface itself.[5] This process is illustrated in Figure 2.

Once bacteria have become adherent, they communicate between themselves via a number of quorum-sensing molecules.[6] These cause phenotypic

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Type	Timing	Presentation
I	Immediate postoperative period	Fever, rigors, sweating, pain Erythematous wound, swollen tender, wound drainage
II	6–24 months	Gradual deterioration in function, increasing pain History of prolonged wound drainage Evidence of poor wound healing, closed sinus Early loosening
III	2 years+	Hematogenous spread Acute febrile episode, accompanied by deterioration in function

FIGURE 1: The Coventry Classification of Arthroplasty Infection.

changes within the bacterial colony such as the downregulation of key metabolic pathways and the production of an exopolymer slime layer of glycoproteins, polysaccharides, and DNA.[7,8] These factors are key in the decreased susceptibility of biofilm infections to antibiotics. Many antibiotics are not able to penetrate the exopolymeric matrix, and those that are able to reach the bacteria are ineffective because the metabolic pathways they act upon are already downregulated.[9]

PREVENTION OF INFECTION

Patient factors

Certain systemic diseases are known to increase patient susceptibility to infection. Diabetes mellitus and rheumatoid arthritis are commonly encountered in the patient seeking hand joint replacement. The American Society of Anaesthetists (ASA) grade of the patient at surgery has been found to correlate with the risk of prosthetic infection. Those of ASA grade III accounted for 75% of the prosthetic infections in 1 cohort.[10]

Environmental factors

Every aspect of the operating environment has an impact on the rate of implant infection. The number of personnel in the operating room directly affects the total bacterial count—each additional 5 people raises the bacterial count by 34 times.

Laminar flow remains controversial, expensive, and not always available to the hand surgeon embarking on joint replacement surgery. Whereas early studies following its development suggested a reduced rate of infection, later work indicated no difference or even an increase in infection rates. Other methods aimed at reducing the overall environmental bacterial count remain equally or more controversial. These include ultraviolet light and alternative ventilation systems.

Surgical technique

It has been established that prophylactic antibiotics may reduce joint infection rates. Regimens vary, but intravenous antibiotics at induction with or without additional postoperative doses are standard. The implant can be coated with an antimicrobial such as silver or contain an antimicrobial for elution. These technologies have not found their way into implants for the hand. Other means of delivering antibiotics to the local milieu include antibiotic-impregnated collagen matrix, which is yet to show a clear benefit in terms of joint infection rates. Other experimental techniques include shock wave treatment and photodynamic therapy and magnetization, which have been shown to reduce colonization rates if applied prior to implantation.[11]

Poor tissue handling can contribute to the risk of wound infection, but it is unclear whether this translates to infection rates following arthroplasty. Suture materials incorporating antimicrobials may have a role.

TREATMENT OF INFECTION

Successful treatment of implant-associated infection requires close collaboration between surgeons and clinical microbiologists to provide an optimal individualized treatment strategy for each patient.

DIAGNOSIS

Implant-associated infections in the hand and upper limb can be difficult to diagnose. Fever and systemic signs are often absent.[12] Chronic infections often present with chronic pain and implant loosening in the absence of any systemic symptoms or local evidence of inflammation, resulting in substantial difficulties in distinguishing between mechanical or aseptic loosening, and infection.

Plain radiographs lack sensitivity and specificity in the diagnosis of implant-related infection.[13] However, they are an essential guide to management when implant removal or retention is being considered. Ultrasound can be useful to identify deep collections and allow for guided aspiration. In the context of metallic hardware, magnetic resonance imaging and computed tomography are of limited benefit.

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