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Debridement for prosthetic joint infections

FUTURE THERAPIES

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Debridement is a central tenet in the management of prosthetic joint infections (PJIs). Modern debridement has three distinct stages: 1) surgical; 2) mechanical/physical; and 3) chemical.[1] Given more recent understanding in the pathogenesis of PJI,[2] the microscopic targeting of the bacterial biofilm and intracellular pathogens should also be included in the art of debridement.[2,3] The adequacy of debridement is critical to the success of single-stage procedures, which have been shown to result in lower patient morbidity and healthcare costs.[4] There is currently an unmet clinical need to optimize debridement in the management of PJI.

Surgical debridement

Novel ultrasonic cutting devices may be beneficial as they selectively apply high strain to hard tissues, while soft tissues such as ligaments and nerves can be deflected without damage.[5]

Mechanical/physical debridement

Non-contact induction heating of metal prostheses delivers localized thermal damage to the biofilm, resulting in bacterial eradication and antibiotic synergism.[6-8] Pulsed electromagnetic fields are used to induce eddy currents within metallic prostheses to generate heat.[7] Low-intensity pulsed ultrasound potentiates antimicrobials when used against biofilms,[3] as well as increasing the in vitro elution of antimicrobials from polymethylmethacrylate cement.[9,10]

Chemical debridement

Topical antiseptic agents, such as Betadine, are only partially effective in the eradication of bacterial biofilms.[11] Ethylenediaminetetraacetic acid (EDTA) is a safe and effective debridement adjunct against multidrug-resistant pathogens in implant-related infections.[12] EDTA, similar to acetic acid,[11,13] already has regulatory approval for its use in the management of superficial wound infections.[14]

Biological debridement

There has been a renewed interest in bacteriophage therapy due to the pending global crisis in antimicrobial resistance.[15] Bacteriophages are viruses that infect and inactivate bacteria. Unlike traditional antibiotics, bacteriophage activity is not limited by bacterial cell dormancy, furthermore the biological cost of acquired resistance to bacteriophages permits phage-susceptible clones to persist within wild-type populations.[15] Host cell internalization allows pathogens to avoid antimicrobial exposure and immune system interaction. One strategy to overcome this problem is the addition of cell-penetrating peptides to both established antimicrobials and novel therapeutics.[16] A further approach is the development of liposome nanocarriers, which are phospholipid vesicles that are able to penetrate both biofilms and mammalian cells.[17] Modified delivery systems using cell-penetrating peptides or liposome nanocarriers would allow co-localization of antimicrobial agents with intracellular pathogens. Monoclonal antibodies that target matrix components of biofilms such as extracellular DNA, virulence factors, and adhesion factors can disperse established biofilms,[18] act synergistically with established antimicrobials to eradicate pathogens,[18] and even inhibit biofilm formation.[19]

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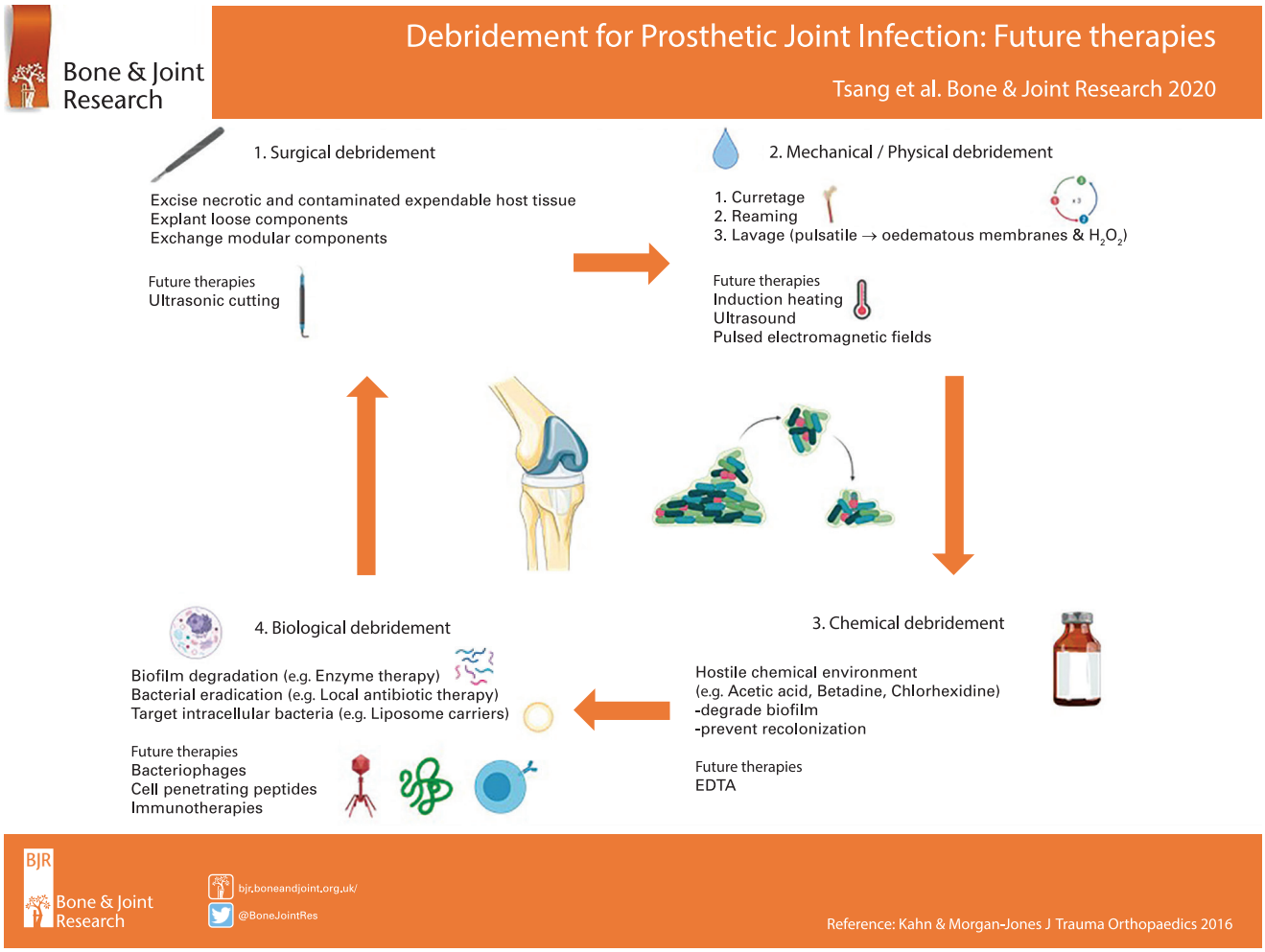
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Debridement for Prosthetic Joint Infection: Future therapies
Tsang et al. Bone & Joint Research 2020
1. Surgical debridement
Excise necrotic and contaminated expendable host tissue
Explant loose components
Exchange modular components
Future therapies
Ultrasonic cutting
2. Mechanical / Physical debridement
1. Curretage
2. Reaming
3. Lavage (pulsatile → oedematous membranes & H_2O_2)
Future therapies
Induction heating
Ultrasound
Pulsed electromagnetic fields
3. Chemical debridement
Hostile chemical environment
(e.g. Acetic acid, Betadine, Chlorhexidine)
-degrade biofilm
-prevent recolonization
Future therapies
EDTA
4. Biological debridement
Biofilm degradation (e.g. Enzyme therapy)
Bacterial eradication (e.g. Local antibiotic therapy)
Target intracellular bacteria (e.g. Liposome carriers)
Future therapies
Bacteriophages
Cell penetrating peptides
Immunotherapies
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