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Review

Biofouling of surgical power tools during routine use

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SUMMARY

Surgical power tools (SPTs) are frequently used in many surgical specialties such as dentistry, orthopaedics, ophthalmology, neurology, and podiatry. They have complex designs that may restrict access to cleaning and sterilization agents and frequently become contaminated with microbial and tissue residues following use. Due to these challenges, surgical power tools can be considered the weak link in the decontamination cycle and present a potential for iatrogenic transmission of infection. We aimed to review the existing literature on the decontamination of surgical power tools and associated iatrogenic transmission of infection. A search of the medical literature was performed using Ovid online using the following databases: Ovid Medline 1950–2014, Embase 1980–2014, and EBM Reviews Full Text – Cochrane DSR, ACP Journal Club, and Dare. Despite challenges to decontamination processes, reported episodes of iatrogenic infection directly linked to SPTs appear rare. This may reflect a true picture but more likely represents incomplete reporting, failure to investigate power tools, or lack of surveillance linking surgical site infections (SSIs) to power tools. Healthcare professionals should be aware of the complexities associated with the decontamination of different SPTs, and should review manufacturers' reprocessing instructions prior to purchase. More clarity is required in the manufacturers' validation of these reprocessing instructions. This particularly applies to the emerging surgical robot systems that present extreme challenges to decontamination between uses. Investigation of cross-infection incidents or SSI surveillance should include an element of assessment of SPT decontamination to further elucidate the contribution of SPTs to skin and soft tissue infections.

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Introduction

Decontamination of medical devices is integral to prevention of iatrogenic infection. Whereas decontamination legislation standards and guidelines are relatively well documented and validated for conventional surgical instruments and endoscopes, there is a general paucity of consolidated information relating to the microbiological decontamination of surgical power tools (SPTs) in the healthcare setting. SPTs have undergone rapid development since the beginning of the nineteenth century when they were first introduced into clinical practice and are now used in many different surgical specialties. Various forms of energy are used to generate power, and this can be harnessed to function a diverse array of instruments such as orthopaedic surgical drills, ultrasonic dental scalers, and laser-delivering dermatology handpieces. During routine use, SPTs are contaminated with biological material

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including bacteria, viruses, blood, and human tissue depending on operating site.[1–12] The reprocessing of SPTs after use is required by the Medical Device Directive and manufacturers of each device are required to provide validated reprocessing methods.[13–15] Concerns have been raised over the effectiveness of decontamination procedures due to the complexity of some instruments and the balance struck between instrument maintenance and the elimination of contamination.[16,17]

It is important to understand the location and nature of contamination in routinely used SPTs before decontamination processes to understand the biological and chemical challenges to these processes. Knowledge of SPT contaminants prior to decontamination will inform the development of rational decontamination processes and aid risk assessments for the potential for iatrogenic transmission of infectious agents. A frequent dilemma in risk assessments and reprocessing decision-making is that power tools are usually attached to drills or other attachments which are directly invasive (and frequently single use); however, the tools themselves are not usually directly invasive.[18] Additionally, the effect of decontamination on performance of multi-use devices should also be a consideration.[19] The aim of this study was to review the literature detailing contamination and the evidence of iatrogenic transmission events associated with different SPT.

Methods

A search of the medical literature was performed using Ovid online with the following databases: Ovid Medline 1950–2014, Embase 1980–2014, and EBM Reviews Full Text – Cochrane DSR, ACP Journal Club, and Dare.

Classification of surgical PTs

Surgical SPT can be classified by the power used to generate the energy that drives, or is delivered through, the SPT. The SPTs considered in this review are those that use rotary power, ultrasonic, and laser energy; in addition, we also consider surgical motorized robotic assistants (Table I).

Rotary power tools

The main clinical applications for rotary SPT are the drilling of structures such as bone to enable access to deeper tissues, removal of diseased tissue and preparation of bone to receive various types of implantable material. Rotary SPTs are used in a wide variety of specialties ranging from dentistry, oral and maxillofacial surgery, orthopaedics, neurosurgery, and podiatry. More recent advances in orthopaedics and minimally invasive surgery have also allowed the use of arthroscopic shavers for access to joints and bones using smaller incisions.[29] These typically consist of rotary handpieces that can be operated at varying speeds in association with burs, blades, and saws and are usually used to debride defective or infected orthopaedic tissue.[30]

History of development

Each rotary SPT from the different clinical specialties has a common ancestor: the dental handpiece (DHP).[31] The development of the rotary handpiece has been reviewed extensively from a neurosurgical and dental context.[31–33] The creation of the modern handpiece was not a linear process and many developments occurred simultaneously, such as the introduction of the foot-powered DHP in the late 1860s.[32,23] The development of the rotary power tool was driven by the desire for easier control by the surgeon and the need for faster rotational speeds to increase patient comfort and take advantage of developments in bur design and materials. Attempts to reach high rotational drill speeds initially were hampered by manual attempts at providing the power for rotational movements in the drill; the development of mechanical motor-driven higher-speed handpieces capable of 10,000 revolutions per minute (rpm) occurred in 1911. By 1956 the top rotational speed of handpieces had increased to 100,000 rpm. Shortly afterwards in 1958, speeds of 300,000 rpm were achieved with the marketing of the Borden Air Rotor, considered to be the first modern high-speed dental handpiece. The high speeds of modern handpieces create a significant amount of friction between the bur and contact surface, potentially causing

Table I
Summary of contaminants detected in surgical power tools

Power tool	Specialties	Contaminants detected before decontamination	Contaminants detected after decontamination
Rotary	Dentistry	Coagulase-negative staphylococci, *Staphylococcus aureus*, *Bacillus* spp., *Streptococcus* spp.	Bacteria including *S. aureus*[20] Hepatitis B DNA[5] Hepatitis C DNA[21]
	Orthopaedic	*Staphylococcus* spp.	Protein[10] DNA[11] Pseudomonas[3]
Ultrasonic	Ophthalmology, neurosurgery, dentistry		Blood[9] Protein[9] Bacteria[4] Fungi (unidentified)[9] Eye lens tissue[9] Viruses[22]
Laser	Dermatology		Cellular debris[23] Herpes simplex virus[6] HIV viral DNA[24] Bacteria[7]
Robotic			Protein[25–28]

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