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The effect of sterile versus non-sterile tourniquets on microbiological colonisation in lower limb surgery

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ABSTRACT

INTRODUCTION Surgical tourniquets are commonplace in lower limb surgery. Several studies have shown that tourniquets can be a potential source of microbial contamination but have not compared the use of sterile versus non-sterile tourniquets in the same procedures.

METHODS Patients undergoing elective orthopaedic lower limb surgery were randomised prospectively to use of non-sterile pneumatic tourniquet or sterile elastic exsanguination tourniquet (S-MART™, OHK Medical Devices, Haifa, Israel). Samples were taken from the ties of the non-sterile tourniquet prior to surgery and from the sterile tourniquets at the end of the operation in a sterile fashion. These were then sealed in universal containers and immediately analysed by the microbiology department on agar plates, cultured and incubated.

RESULTS Thirty-four non-sterile tourniquets were sampled prior to surgical application, twenty-three of which were contaminated with several different organisms including coagulase-negative *Staphylococcus* spp, *Staphylococcus aureus*, *Sphingomonas paucimobilis*, *Bacillus* spp, and coliforms. Thirty-six sterile tourniquets were used, with no associated contamination.

CONCLUSIONS There was significant contamination of 68% of orthopaedic surgical tourniquets. These are used regularly in procedures involving the placement of prosthesis and metalwork, and can act as a potential source of infection. We recommend the use of sterile single-use disposable tourniquets where possible. The availability of an alternative should now set the new standard of care and we recommend adopting this as a current NICE guideline for control of surgical site infection.

KEYWORDS

Tourniquet – Equipment contamination – Orthopedic equipment – Lower extremity – Agar plate

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Surgical tourniquets are commonplace in lower limb surgery as a bloodless field is necessary in many orthopaedic procedures. Previous studies have shown that tourniquets can be a potential source of microbial contamination but have not compared the use of sterile versus non-sterile tourniquets in the same procedures.[1] We hypothesised that tourniquets could be a cause of surgical site and prosthetic infection through microbial contamination.

Non-sterile medical equipment is used frequently in the sterile environment of the operating theatre. Studies have shown that medical equipment can be colonised and contaminated with bacteria that can be transferred to the operating room environment.[2–5] The tourniquets in theatre are very rarely cleaned according to the manufacturer's guidelines between cases. They are often stored in the pneumatic tourniquet box in close proximity to the ground, with parts in contact with the ground, other tourniquets or the Rhys-Davies exsanguinator (a common haven for bacteria).[6]

Surgical site infections (SSIs) place a huge financial burden on the healthcare system.[7] More importantly, SSIs confer a distinct disadvantage on the patient, who will invariably need to undergo further blood tests, intravenous antibiotic administration, prolonged exposure to radiology and possibly the need for revision surgery.[8]

Manufacturers offer orthopaedic tourniquets that are sterile and disposable, designed for use on one procedure only. Our trust uses both disposable sterile elastic exsanguination tourniquets (EETs) (S-MART™, OHK Medical Devices, Haifa, Israel) and re-usable non-sterile pneumatic tourniquets (OHK Medical Devices). The choice is down to the surgeon's preference. There is no NICE guidance on this issue although otherwise thorough guidelines on preventing SSIs have been published.[9]

Methods

This was a prospective randomised clinical trial where patients from two district general hospitals in one NHS trust were randomised to either sterile or non-sterile tourniquet groups. The patients were screened for methicillin-resistant *Staphylococcus aureus* (MRSA) prior to surgery in accordance with trust guidelines. All the procedures were commonplace elective knee procedures including arthroscopy and total knee arthroplasty undertaken in laminar flow theatres.

Samples were taken from the ties around the non-sterile tourniquet prior to surgery using an aseptic sterile technique. The areas sampled were not integral to the tourniquet function itself but were in contact with the patient throughout the procedure. A biopsy of the main body of the sterile tourniquet was taken at the end of the procedure in a sterile fashion using a new surgical blade and new surgical gloves and gown.

A total of 34 non-sterile and 36 sterile tourniquets were sampled. There were no complications with obtaining the specimens. Standardised conditions used throughout the study ensured that cross-contamination did not occur.

The specimens were sealed in universal containers and taken to the microbiological laboratories in the same trust. They were examined and tested by one biomedical scientist throughout who was blinded to the source of the tourniquet samples. The samples were placed onto whole Columbia blood agar plates and an aseptic technique was used to transfer both sides of the tourniquet to the agar. The plates were then incubated at 35°C for 48 hours in air. The agar was examined and bacterial type and colony count were recorded.

Results

In the non-sterile tourniquet group, 23 of 34 tourniquets (68%) were contaminated, whereas none of the 36 sterile tourniquets were colonised. This difference was statistically significant ($p<0.01$). Colony counts were low, ranging from 1 to >61, with some tourniquets yielding more than one bacterial species. Significant numbers of skin flora were identified but no MRSA was isolated.

The main bacterial species isolated was coagulase-negative *Staphylococcus* spp, which occurred in 11 of the 23 positive samples (32% of total). *Bacillus* spp was present on eight samples (24%), coliform species on three samples (9%) and *Sphingomonas paucimobilis* on one sample. *Staphylococcus aureus* was found with coagulase-negative *Staphylococcus* spp on two tourniquets.

Discussion

This study is the first to compare the bacterial load of non-sterile pneumatic versus sterile elastic exsanguination tourniquets (EETs) used for the control of bleeding in lower limb surgical procedures. The results show unequivocally that the sterile EET is growth-free, not only as it comes out of the package but also at the end of the procedure, whereas the non-sterile pneumatic tourniquet is contaminated in 23 of 34 of cases (68%). Reusing non-sterile tourniquets may therefore result in the transfer of bacteria between patients.

The bacterial species identified are commonly found on human skin or excretions including coagulase-negative *Staphylococcus* spp, the most common cause of joint infection in total knee replacement and arthroscopy.[10,11] Such infections develop in 1–3% of knee surgical procedures[10] and are associated with poor outcome and increased cost.[8] Although the colony counts were low, it is certainly possible that bacteria will move from the tourniquet to the surgical field during surgery or when dressing the wound.

When compared with recent work on the bacterial load in non-sterile tourniquets,[1,12] our study actually found a lesser degree of contamination. These other studies found 100% contamination of all non-sterile pneumatic tourniquets although one demonstrated that colonisation was reduced by 99.2% when cleaned in accordance with the manufacturer's guidelines.[1] This difference may be related to a higher level of overall infection control and cleanliness in the theatres we studied or a difference in sampling and culture technique. In any event, since the same technique was used for the non-sterile tourniquet and the EET, the difference in contamination in this study is significant and valid.

The logical conclusion may be that reducing bacterial load in close proximity to the surgical site will reduce SSIs. However, this is yet to be demonstrated by a prospective and blinded controlled study, and subsequent studies may go further than this one in following up the patients to determine if the organisms isolated caused SSIs. Our study did not address other differences between the two types of tourniquet such as ease of use and efficacy in terms of achieving a bloodless field. Anecdotally, the surgeons in this study preferred the sterile EET.

Conclusions

This study clearly documented the bacterial load of pneumatic tourniquets and presented the fact that an alternative EET is not contaminated. Putting all other considerations in favour of the use of EET aside, we conclude that using contaminated non-sterile tourniquets in surgical procedures that often involve insertion of foreign materials into the human body is not advisable. The availability of an alternative should now set the new standard of care and we recommend adopting this as a current NICE guideline for control of SSI.

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