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Comparing sterile bag rubbing and paint on technique in skin preparation of the hands

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Key words
bag rubbing hand surgery, Betadine, skin preparation, surgical site infection.

Abbreviations
CFU, colony-forming unit.

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Abstract

Background: The aim of this study was to compare two techniques for surgical site skin preparation in hand surgery.
Methods: We compared the standard sponge paint technique versus a plastic bag immersion technique using a 10% povidone–iodine with alcohol solution (Betadine, ORION Laboratories Pty Ltd, Balcatta, WA, Australia) to prepare surgical site skin for hand surgery. This sterile bag rubbing technique involves using a sterile plastic bag filled with 60 mL of Betadine solution to immerse the subjects' hand. Samples were taken from 10 subjects for bacteria colony-forming unit (CFU) counts before and 3 min after surgical site preparation in each group. Outcome measures were preparation time and CFU reduction with a plate impression test using commercially available agar slides.
Results: The sterile bag rubbing technique significantly reduced ($P < 0.0001$) the time required for surgical site skin preparation (28 s) compared with the standard technique (86 s). Both techniques were found to have similar efficacy in the reduction of CFU.
Conclusions: The sterile bag rubbing technique is a quicker alternative method for surgical site preparation in hand surgery and has comparable efficacy to the widely practised standard paint-on technique.

Introduction

Surgical site infection (SSI) in elective hand surgery is common.[1] Preparation of the hands with antiseptic solution is a time-consuming procedure. Complete coverage of antiseptic solution in the nail fold area and web space using the traditional sponge on forceps technique can be difficult to achieve especially in the deformed hands. Although current literature on surgical site infection has focused on the effectiveness of hand washing and various antiseptic agents,[2–4] there is limited evidence on the preparation methods.

We investigate an alternative preparation technique by rubbing of antiseptic solution in a sterile bag. The technique allows the surgeon to directly apply antiseptic solution within the sterile bag to ensure full coverage of the surgical site without cross contamination. The theoretical advantage is threefold: thin plastic membrane enables easier access to the flexed hand creases than thick sponge, better control of the patient's hand during preparation and, overall, a more efficient preparation process.

This study aims to investigate the efficacy of a different technique to prepare the surgical site in hand surgery. We compare the preparation time and efficacy of this technique to the widely practised sponge paint-on technique.

Methods

This study has been approved by the Regional Ethics Committee and complies with the Declaration of Helsinki Guidelines. Ten healthy adult volunteers were recruited into the study. The exclusion criteria were: systemic or local antibiotic therapy within the preceding 2 weeks, open hand wounds or infection, skin disorders or allergy to Betadine.

Fig. 1. Application of sterile bag with rubbing of antiseptic solution onto the hand.

The experiment was performed in a sterile operating room setting. The two hand preparation techniques are described below.

Standard sponge paint technique

The sterile technique involved an assistant to raise the patient's hand while the surgeon applied 60 mL Betadine with alcohol skin antiseptic solution (10% w/w povidone–iodine) from elbow to fingertips with a sponge-holding forceps. Attention was paid to ensure complete coverage of difficult areas such as nail folds, palmar creases and web spaces. The coverage was then checked by an independent observer.

Sterile bag immersion technique

This technique involved using a transparent sterile bowel bag with a purse string at its opening. The bag was filled with 60 mL Betadine with alcohol skin antiseptic solution (10% povidone–iodine). The participant's forearm was placed into the sterile bag and immersed in the Betadine solution. The proximal end was then sealed at the elbow using the purse string. The theatre staff wearing sterile gloves rubbed over the plastic bag to create a Betadine lather that directly covered the surgical site (Fig. 1). The hand, web spaces and fingertips were closely examined to ensure complete coverage by an independent observer. The purse string was released, and the neck of the bag was folded back in a retrograde fashion to avoid contamination of the prepared skin surface.

Preparation time recording

Time to prepare the limb using each technique was measured using a digital timer and recorded by an independent observer. The time taken to prepare the limb began when the Betadine solution was first applied to the skin and ended when complete coverage of the surgical site was achieved.

Bacteriological sampling

Bacteriological sampling was performed using Hygiene Check Slides (Fort Richard Laboratories Ltd., Otahuhu, Auckland, New Zealand), which contains microbial content test agar with an iodophor-neutralizing agent (tryptic soy agar with lecithin and polysorbate 80). Impression testing was done using direct contact to the fingertips and palmar skin surface. Sampling was first performed at each site prior to any skin preparation. Skin preparation was then performed as described above. The antiseptic solution was allowed to air-dry for 3 min. At this point, repeat microbial impression testing was performed. The samples were stored in an incubator at 37°C for 48 h. Bacteria colony-forming unit (CFU) counts were performed by two individuals blinded to the sampling process. Gram stain was performed on all positive samples and reviewed by a microbiologist.

Statistical analysis

The absolute reduction in bacterial colony counts was calculated. Statistical analysis was performed using the Mann–Whitney test comparing the reduction in CFU counts between the two methods and between sampling sites (fingertips versus palmar surface). A *P*-value of 0.05 or less was considered to be a statistically significant reduction in bacterial load.

Results

Preparation time

The average time required for the standard sponge paint technique was 85.5 s (1 standard deviation = 11.9 s). In comparison, the average time for the sterile bag technique was 28.2 s (1 standard deviation = 10.7). The difference in preparation time between the two methods was statistically significant ($P < 0.0001$) (Fig. 2).

Efficacy

The efficacy of each preparation method, as measured by reduction in CFU counts, was comparable (Table 1,2). There was a high variability of CFU counts before preparation between the 10 participants; however, both methods significantly reduced CFU counts of both the fingertips and the palm ($P < 0.0001$).

Examination of the fingertip samples showed that the standard paint method reduced CFU counts from an average of 93.2 to 3.7 (91.3% deduction). The bag method reduced CFU counts from an average of 79.1 to 1.2 (98.6%). The difference in CFU count reduction between the two methods was not statistically significant ($P = 0.79$).

Examination of the palm samples showed that the standard paint method reduced CFU counts from an average of 45.4 to 0.3 (99.4%). The bag method reduced CFU counts from an average of 45.7 to 1.7 (97.4%). The difference in CFU count reduction between the two methods was also not statistically significant ($P = 0.37$).

Bacterial analysis

Positive cultures before and after skin preparation were reviewed. Predominantly Gram-positive cocci were isolated from culture

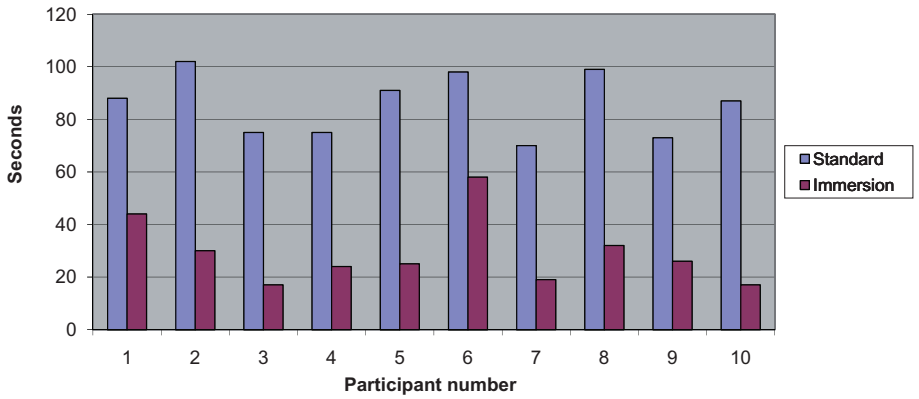

Fig. 2. Preparation time of standard sponge paint technique (blue) versus bag rubbing (red) technique.

Table 1 Mean colony-forming unit (CFU) counts with 1 standard deviation in the fingertip group

Fingertip	CFU counts Before preparation	CFU counts After preparation	Percentage reduction
Standard sponge paint	93.2 ± 67.6	3.7 ± 10.3	91.27 ± 25.95
Bag rubbing	79.1 ± 52.0	1.2 ± 1.7	98.61 ± 2.29

Table 2 Mean colony-forming unit (CFU) counts with 1 standard deviation in the palm group

Palm	CFU counts Before preparation	CFU counts After preparation	Percentage reduction
Standard sponge paint	45.4 ± 28.4	0.3 ± 0.7	99.43 ± 1.42
Bag rubbing	45.7 ± 33.2	1.7 ± 3.2	97.35 ± 4.62

before skin preparation. Following preparation with both techniques, the majority of the culture has grown Gram-positive spore-forming bacilli representing the *Bacillus cereus* species. This showed elimination of the highly pathogenic bacterial species with both preparation techniques.

Discussion

Surgical site infection is multifactorial and can cause considerable morbidity. In principle, the risk of infection following surgery relates to the size of the bacterial inoculum entering an exposed surgical wound, the size of the wound and the duration that the wound is open. The overall post-operative wound infection rate in elective and emergency hand surgery has been reported to be as high as 10%.[1] Surgical site infection involving flora from a surgeon's hands is rare. Most infections can be attributed to endogenous organisms from patients.[5] Bacteria reside in the desquamating, cornified layers of the superficial epithelium of the skin as well as in glandular ducts and the depths of hair follicles.[6] The risk of post-surgical wound site infection increases substantially when $\geq 10^5$ bacteria per gram of tissue is present.[7] Appropriate preoperative skin preparation aims to effectively minimize the bacterial load and therefore reduces the risk of surgical site infection.[8]

Preoperative surgical site skin preparation traditionally involves a standard sponge paint technique. This study shows that surgical site skin preparation with the bag technique containing 10% Betadine and alcohol solution is simple to perform and less time consuming than the standard sponge paint technique. Both techniques have similar efficacy in the reduction of bacterial CFU counts. Recent study by Incoll *et al*. has suggested that bag immersion achieves superior results than the standard paint-on technique.[9]

The benefits of using a sterile bag in skin site preparation in hand surgery include less time taken to prepare operative area, less trauma caused to operative area and the ability to prepare operative areas that are difficult to reach (e.g. deformities such as trigger finger or Dupuytren's contractures). Harsh scrubbing has been shown to cause skin micro-excoriation, which liberates bacteria.[10] In addition, our cost analysis showed a reduced overall cost with the use of the sterile bag technique, taking into account various expenses including theatre time cost.

The limitations of this study include a small sample size and the volunteers being not representative of patients undergoing hand surgery. It is also uncertain that the reduction of CFU counts reflects lower risk of surgical site infection. We therefore recommend further clinical trials with a large-scale sample before it is practised.

The sterile bag technique effectively reduces the bacterial CFUs. This is more efficient than the traditional paint-on application. This preparation technique has the potential implications to be applied in foot and ankle surgery, and also across multiple surgical disciplines such as vascular and plastic surgery.

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