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Bacterial Skin Contamination After Surgical Preparation in Foot and Ankle Surgery

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An effective presurgical preparation is an important step in limiting surgical wound contamination and preventing infection. The purpose of this study was to evaluate residual bacterial skin contamination after surgical skin preparation in foot and ankle surgery to determine if current techniques are satisfactory in eliminating harmful pathogens. Fifty consecutive patients having surgical procedures of the foot and ankle were studied. Each lower extremity was prepared randomly with either a one-step povidone-iodine topical gel or a two-step iodophor scrub followed by a povidone-iodine paint. After preparation and draping, cultures were obtained at three locations: the hallux nailfold, web space between the second and third, and fourth and fifth toes, and the anterior ankle (control). In the gel group, positive cultures were obtained from 76% of halluces, 68% of toes, and 16% of controls. In the scrub and paint group, positive cultures were obtained from 84% of halluces, 76% of toes, and 28% of controls. Numerous pathogens were cultured, with Staphylococcus epidermidis being the most prevalent. Based on the findings of the current study, presurgical skin preparation with a povidone-iodine based topical bactericidal agent is not sufficient in eliminating pathogens in foot and ankle surgery. The unique environment of the foot and its resident organisms may play a role in the higher infection rates associated with surgery of the foot and ankle.

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The consequences of postoperative infection in foot and ankle surgery are potentially serious. Infection may result in septic arthritis with destruction of cartilage, osteomyelitis, amputation of the limb, sepsis, or death. Studies evaluating the incidence of infection in foot and ankle surgery have shown higher infection rates when compared with procedures done on other areas of the body.[4,5,7,9,10,12] Multiple factors affect postoperative infection rates including patient comorbidities, operating room environment, perioperative antibiotic use, and presurgical skin preparation with a topical bactericidal agent. However, the foot provides a unique environment for harboring potential wound pathogens.[6,11] The purpose of this study was to evaluate residual bacterial skin contamination after surgical skin preparation in foot

and ankle surgery to determine if current techniques are satisfactory in eliminating harmful pathogens. Two preoperative skin preparation protocols used at the authors' institutions were compared.

MATERIALS AND METHODS

Fifty feet and ankles in 50 consecutive patients having surgical procedures of the foot and ankle at two hospitals between November 1999 and February 2000 were studied. Twenty men and 30 women were included in the study. Twenty-nine patients were treated at one facility and 21 were treated at a second facility. The two hospitals employed different operating room personnel. The mean age of the patients was 47 years (range, 19–79 years). Overall, the patient population was healthy. Two patients had diabetes, two had a history of rheumatoid arthritis, one was human immunodeficiency virus positive, one had alcohol-induced peripheral neuropathy, and one patient had spinocerebellar ataxia. No patient was included if there was an open wound or current infection.

All patients received a preoperative dose of antibiotics (cefazolin, 1 g intravenously) within 1 hour of the surgical start time. The operative lower extremity was prepared randomly according to the manufacturer's instructions with either a one-step povidone-iodine topical gel (iodine 1%) (Solo-Prep 171, Clinipad Corp, Rocky Hill, CT) or a two-step iodophor scrub (iodine 0.75%) followed by a povidone-iodine paint (iodine 1%) (E-Z Prep 270, Clinipad Corp). Twenty-five patients received the one-step gel preparation and 25 received the two-step scrub and paint preparation. After the preparation and draping were complete, three separate swabs were used to culture three locations on the foot and ankle. The first culture was taken from the anterior ankle at the level of the joint. This was used as the control. The second culture was taken from the nail-fold of the great toe (hallux). The final culture was taken from the web space between the second and third, and fourth and fifth digits (toes). All specimens were placed immediately into Amies transport media (Becton Dickinson, Franklin Lakes, NJ) and sent to the microbiology laboratory for aerobic, anaerobic, and fungal cultures.

Based on the high frequency of positive cultures obtained early in the study, the last 40 patients had their distal foot wrapped with Ioban™ (3M Health Care, St Paul, MN) after the preoperative skin preparation if the procedure did not involve the toes.

Statistical Analysis

Chi square analysis was used to evaluate the difference in culture rates between the study groups. A p value less than 0.05 was considered significant.

RESULTS

In the gel group, positive cultures were obtained from 19 (76%) halluces, 17 (68%) toes, and four (16%) controls (Table 1). In the scrub and paint group, positive cultures were obtained from 21 (84%) halluces, 19 (76%) toes, and seven (28%) controls (Table 2). When looking at all 50 patients together, positive cultures were obtained from 40 (80%) halluces, 36 (72%) toes, and 11 (22%) controls.

Of the 150 total cultures obtained, 87 were positive for at least one organism. Many specimens grew multiple organisms. Many potential pathogens were found (Fig 1). Of the 87 positive cultures (135 different bacterial isolates), 69 grew Staphylococcus epidermidis, and eight grew Staphylococcus aureus (in seven patients). Enterococcus faecalis and Clostridium perfringens were cultured from one patient each. Only one patient had a positive fungal culture. This patient had spinocerebellar ataxia and the culture specimen grew Chaetomium from hallux and toes.

In the one-step gel group there was a statistically significant higher positive culture rate from the hallux compared with the control site ($p < 0.01$) and from the toes compared with the control site ($p < 0.01$). In the two-step scrub and paint group there was also a statistically significant higher positive culture rate from the hallux compared with the control site ($p < 0.01$) and from the toes compared with the control site ($p < 0.05$). There was no difference in positive culture rate between hallux and toes in either group. There was no difference between the two preoperative preparation protocols. No difference in positive culture rate was found between men and women. There was no difference in positive culture rate between the two hospitals.

TABLE 1. Culture Results From Patients in the One-Step Gel Surgical Scrub Group

Patient	Age/Gender	Hallux	Toes	Ankle (Control)
1	58 F	Staphylococcus epidermidis		
2	39 F	Staphylococcus epidermidis Diptheroid		
3	59 F			
4	20 F	Diptheroid Klebsiella pneumoniae Stenotrophomonas maltophilia Staphylococcus aureus	Bacillus	
5	73 F	Clostridium perfringens Staphylococcus epidermidis	Staphylococcus epidermidis Diptheroid Peptostreptococcus	
6	35 M			
7	25 F			
8	53 F	Staphylococcus epidermidis Bacillus	Staphylococcus epidermidis	
9	19 F	Staphylococcus epidermidis Bacillus	Bacillus	
10	64 F	Staphylococcus aureus Bacillus	Bacillus	Bacillus
11	78 F	Staphylococcus epidermidis	Staphylococcus epidermidis	Staphylococcus epidermidis
12	28 F	Staphylococcus epidermidis	Bacillus	
13	34 M	Staphylococcus epidermidis	Staphylococcus epidermidis	
14	38 M	Staphylococcus aureus Staphylococcus epidermidis Bacillus	Staphylococcus epidermidis	
15	51 F	Staphylococcus epidermidis	Staphylococcus epidermidis Streptococcus viridans	
16	75 M	Staphylococcus epidermidis	Staphylococcus epidermidis	
17	68 F	Staphylococcus epidermidis		
18	44 F			
19	68 F			
20	77 F	Staphylococcus epidermidis, two strains	Diptheroid Staphylococcus epidermidis, two strains	
21	20 M	Staphylococcus epidermidis, two strains Bacillus	Bacillus, two strains Staphylococcus epidermidis	
22	47 M	Staphylococcus epidermidis Bacillus Fugus chaetomium	Staphylococcus epidermidis, two strains Fungus chaetomium	
23	37 M		Staphylococcus epidermidis	Propionibacterium acnes
24	71 M	Staphylococcus epidermidis, two strains	Staphylococcus epidermidis	
25	49 F	Staphylococcus epidermidis, three strains	Streptococcus viridans	Propionibacterium acnes Peptostreptococcus anaerobius

TABLE 2. Culture Results From Patients in the Two-Step Scrub and Paint Surgical Scrub Group

Patient	Age/Gender	Hallux	Toes	Ankle (Control)
1	54 M		Staphylococcus epidermidis	
2	44 F	Staphylococcus epidermidis		
3	38 M	Staphylococcus epidermidis Staphylococcus aureus		Staphylococcus epidermidis
4	54 M	Staphylococcus epidermidis, three strains	Staphylococcus epidermidis, three strains	Staphylococcus epidermidis
5	29 M	Staphylococcus epidermidis	Staphylococcus epidermidis	Micrococcus
6	55 F	Staphylococcus epidermidis, three strains Propionibacterium acnes	Staphylococcus epidermidis, three strains Peptostreptoccus	Staphylococcus epidermidis
7	41 M	Staphylococcus epidermidis, two strains heroid, two strains	Staphylococcus epidermidis, two strains Diptheroid	
8	58 F		Staphylococcus epidermidis Staphylococcus aureus Diptheroid	Staphylococcus epidermidis, two strains
9	42 M	Staphylococcus epidermidis, three strains Micrococcus	Staphylococcus epidermidis	Micrococcus
10	78 F	Staphylococcus epidermidis Bacillus	Bacillus	
11	52 F	Staphylococcus epidermidis, two strains Micrococcus	Staphylococcus epidermidis	
12	39 M	Bacillus Staphylococcus epidermidis	Staphylococcus epidermidis	
13	21 F	Bacillus Staphylococcus epidermidis Streptococcus viridans	Bacillus	
14	79 F	Bacillus Staphylococcus epidermidis Propionibacterium acnes	Bacillus	
15	26 M	Staphylococcus epidermidis	Staphylococcus epidermidis	
16	58 M	Bacillus Staphylococcus epidermidis Micrococcus Peptostreptococcus	Staphylococcus epidermidis, two strains Diptheroid	
17	37 F	Staphylococcus epidermidis		
18	58 F	Bacillus Staphylococcus epidermidis	Bacillus	Bacillus
19	43 F		Bacillus	
20	54 F	Staphylococcus epidermidis	Bacillus Staphylococcus epidermidis	
21	42 F	Staphylococcus epidermidis, three strains Diptheroid	Staphylococcus epidermidis	
22	55 M	Staphylococcus epidermidis, three strains Diptheroid	Staphylococcus epidermidis Propionibacterium acnes	
23	27 F	Bacillus Staphylococcus epidermidis		
24	40 M	Staphylococcus epidermidis		
25	41 M			

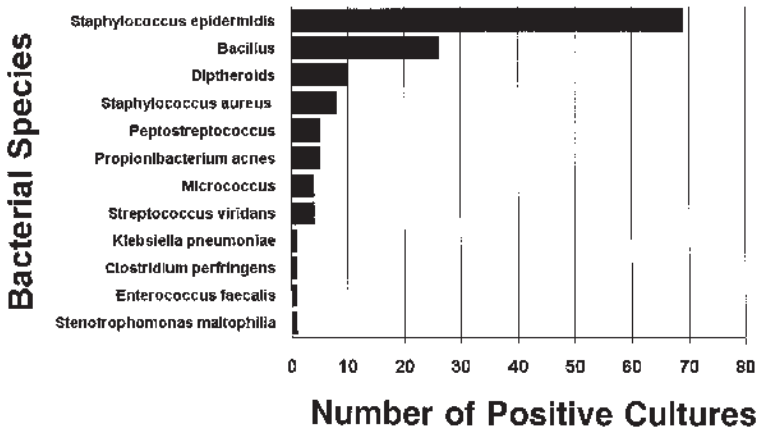

Fig 1. This graph shows the number of positive cultures for each of the bacterial species identified. These numbers include positive cultures taken from hallux, toes, and controls.

There was one postoperative infection in a patient with diabetes who did not have his distal foot wrapped in Ioban™ before the procedure. Enterobacter cloacae, a pathogen not found on his preoperative cultures, grew in the infected wound.

DISCUSSION

This study evaluated the residual bacterial skin contamination after surgical skin preparation in foot and ankle surgery. Despite the use of povidone-iodine based antibacterial scrubs (as per the manufacturer's recommendations), the majority of halluces and toes had positive cultures for potential bacterial wound pathogens. Many bacterial species were found including virulent organisms such as Staphylococcus aureus, Clostridium perfringens, and Enterococcus faecalis. Only one patient had a positive fungal culture, Chaetomium, a soil fungus that only rarely causes disease in humans.[3] Staphylococcus epidermidis, a coagulase-negative staphylococcus, was the most prevalent organism identified. Previously regarded as a contaminant or harmless commensal on the skin, Staphylococcus epidermidis now is recognized as a major cause of infections with the use of prosthetic devices and surgical implants.[8] Foreign bodies, such as orthopaedic devices, are susceptible to bacterial contamination during implantation.[2] Some strains of Staphylococcus epidermidis produce a viscous glycocalyx biofilm that facilitates adhesion to smooth prosthetic surfaces and protects them from antibiotics and natural host defenses.[2,13] Taylor et al[12] found that staphylococci were identified in 83% of orthopaedic cases in which an infection developed. Pure cultures of Staphylococcus aureus were found in 33% and coagulase-negative staphylococcus in 16%. Sinisaari et al[10] also found that Staphylococcus aureus and Staphylococcus epidermidis were the most commonly observed species in postoperative infection after open reduction and internal fixation of ankle fractures. Although several organisms identified on surveillance cultures are normal skin flora, there are reports of all these bacteria being capable of producing soft tissue, bone, or joint infections.

No statistical difference was found in the rate of positive cultures between the two povidone-iodine surgical scrub protocols. Although they possess the same active ingredient, the one-step gel protocol requires only one application without a significant scrub. It therefore is easier and quicker to apply. No difference was found in culture rates between men or women. There was no difference in results when comparing the two hospitals involved.

Studies have shown higher postoperative infection rates after foot and ankle surgery when compared with procedures done on other areas of the body.[4,5,7,9,10,12] After evaluating the outcomes of 12,907 consecutive orthopaedic procedures, Taylor et al[12] found an infection rate of 9.3% in ankle fusions and 5.8% in subtalar fusions. Sinisaari et al[10] evaluated 3084 patients who had open reduction and internal fixation of closed ankle fractures and found an infection rate of approximately 4%. The foot provides a unique environment for growth of numerous bacterial species.[6,11] The presence of the nail, hyponychium, and nailfold make presterilization of these areas difficult.[14,15] Based on the current study, it is clear that the hallux and toes harbor potential pathogens that are not eradicated using a povidone-iodine presurgical scrub. Although multiple factors affect postoperative infection rates, the unique environment of the foot and its resident organisms may play a role in the higher infection rates associated with surgery of the foot and ankle. Quantitative cultures would have added more information regarding the efficacy of these agents. However, no data are available which quantitate the number of bacteria required to colonize an implant or wound and cause an infection. The presence of any bacteria in the surgical field should be a concern.

Based on the results of cultures obtained early in the study, the toes were isolated from the surgical field using Ioban™ as an antimicrobial barrier. None of the patients who had Ioban™ wrapping had a postoperative infection develop. A larger number of patients is needed to show the effects of such a barrier on infection rates. This was not the objective of this study, however.

The consequences of postoperative infection potentially are serious. All effort should be made to minimize the incidence of postoperative infection. The current findings showed that presterilization of the toes with two povidone-iodine surgical scrub protocols was not possible in a majority of patients. Although it was not proven that the presence of these organisms is responsible for the higher infection rates in foot and ankle surgery, it may play a role. Special scrub techniques may be necessary to address the unique anatomy of the foot. Brooks et al[1] reported that additional scrubbing in the toe clefts before surgery reduces the incidence of bacterial recolonization during the surgical procedure. An effective presurgical scrub should adequately reduce the bacterial load and prevent significant recolonization throughout the surgery. However, inability to decrease the bacterial load initially makes subsequent recolonization irrelevant. Additional studies are being done to determine if other surgical scrub solutions or techniques are more effective in eliminating potential pathogens from the toes. If surgical scrubs are not effective in achieving sterilization of the forefoot before surgery, a mechanical or bactericidal barrier wrapped around the toes may be a practical adjuvant. The effect of isolating the toes from the surgical field on postoperative infection rates needs additional study, however.

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