Comparison of the Effectiveness in Bacterial Decontamination between Chlorhexidine Gluconate and Povidone-Iodine Solution in Foot and Ankle: A Pilot Study

Likit Rugpolmuang MD*,
Roongroj Thanabodeethada MD*, Kongkhet Riansuwan MD*

** Department of Orthopaedic Surgery, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand*

Background: *The decontamination for foot and ankle surgery should be considered as a special preparation due to higher rate of bacterial contamination. The footwear and humidity is also the issue of interest especially in tropical country. The contamination before surgery should be reduced to avoid the infection. The effectiveness of antiseptics and special condition for the foot and ankle surgery should be elucidated for better medical care.*
Material and Method: *The twenty volunteers were included in the present study. In group I, the foot was scrubbed with 7.5% Povidone-Iodine and painted with 10% Povidone-Iodine solution. In group II, the foot was scrubbed with Chlorhexidine gluconate scrub and painted with 2% Chlorhexidine gluconate in 70% alcohol. At the beginning and end of the preparation, specimens were taking from all toes, nail fold, interdigital web spaces. These samples were sent for aerobic bacterial cultures. The results were interpreted as positive or negative cultivation and the number of bacterial colonies.*
Results: *All of the samples from 40 feet were collected; In Group I, positive culture was 5 samples (25%). In Group II, positive culture was 2 samples (10%) (p = 0.2).*
Conclusion: *The Chlorhexidine gluconate and Povidone-Iodine are effective in reduction the number of bacterial colonization. The steps of preparation before surgery also play an important role in eliminating the pathogenic bacteria. Both antiseptics were found no significant different in efficacy of pathogenic bacteria reduction.*

Keywords: *Surgical disinfection, Hibitane, Chlorhexidine gluconate, Betadine, Povidone-Iodine, Foot and ankle surgery, Bacterial contamination*

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The orthopaedic surgery in foot and ankle area, now a day, is more often concern for the excellent result. The surgery to correct the deformity in foot and ankle are increased in number. The safety factor to consider, even more than the amount of surgical corrected deformity, is the infection rate. The infected wound around the feet and toes were considered as a disability in independent individual. The safe procedure to avoid the infection around foot area depends on several factors. To our knowledge the most important factor is the pre-surgical cleaning of the planned incised skin. Skin preparation is determined as a method to minimize the risk of wound infection for this instance. Many techniques and different kind of disinfectants have been used to achieve such purpose, however, no consensus has been accepted as a standard procedure to prevent this particular infection in general practice. Several antiseptics were introduced in several purposes such as sterilization before indwelling catheter[1], surgical hand wash[2] and sterilization before skin graft harvest[3]. In the special circumstance such as in tropical country, the behavior in using footwear is different from western country. The contamination which is more commonly found in humid atmosphere was playing a role in the infection after foot and ankle surgery. The exact guideline for decontamination in each type of special circumstance is still unspecified. The present study want to compare the efficacy of bacterial decontamination between using 7.5% Povidone-Iodine scrub with 10% Povidone-Iodine paint and 4% Chlorhexidine gluconate scrub then 2% Chlorhexidine in 70% alcohol paint in foot and toes region.

Correspondence to:
Rugpolmuang L, Department of Orthopaedic Surgery, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok 10400, Thailand.
Phone: 0-2419-7968
E-mail: Likit105@yahoo.com

Material and Method

The present study was conducted between May 2008 and July 2008 in the volunteers who received medical attention at out-patient department, Faculty of Medicine Siriraj Hospital, Mahidol University. Institutional Review Board approval was obtained. Twenty volunteers were enrolled in the present study. No special instructions for bathing or showering were implemented before the study. Patients were allowed for usual personal hygiene cleansing routinely on the day of the present study. Patients with opened wounds, skin ulcers and/or sores, an active or chronic infection, or who were on active antimicrobial therapy, allergy to Chlorhexidine gluconate or Povidone-Iodine were excluded from the study. The both limbs were included in the present study. The simple randomization was used to choose which limb fit for group 1 and group 2. Before the process of skin preparation, two Cotton tipped swabs were applied to obtain the samples from each toe, each web spaces, and nail folds. The swabs were sealed, placed in a sterile container and immediately transported and processed for bacterial cultivation.

In group I, the feet were scrubbed with 7.5% Povidone-Iodine for 7 minutes. Then the feet were dried with sterile towel. Finally, the feet were painted with 10% Povidone-Iodine solution. In group II, the feet were scrubbed with 4% Chlorhexidine gluconate for 7 minutes. Then the feet were dried with sterile towel. Finally the feet were painted with Chlorhexidine in 70% alcohol. The prepared feet were allowed to dry under normal atmosphere. Swabs were applied for the sample with the same manner.

All culture swabs were placed into Brain-heart infusion broth and were vortexes, inoculated onto blood agar, Mac-Conkey agar and mannitol salt agar. The specimens were incubated in 5% CO^2 atmosphere at 35°C. The samples were examined every 24 hours for 5 days. Number of bacterial colony was measured in Colony Forming Unit/mL (CFU/mL).

Statistical analysis

A power analysis (nQuery Advisor) indicated that a sample size of 20 in each group would provide 80% power to detect a significant difference between two groups. Chi-square analysis was used to evaluate the difference in culture rate between the present study groups. Means of colony amount was compared using unpaired Student's t-test. A p-value less than 0.05 were considered significant.

Table 1. Table showing the number of positive cultures between both groups of antiseptics

	Culture positive	Culture negative
Povidone-Iodine (Group I)	5/20 (25%)	15/20 (75%)
Chlorhexidine (Group II)	2/20 (10%)	18/20 (90%)

Results

Twenty volunteers (40 feet) were prospectively enrolled. The present study group consisted of 11 males and 9 females with an age range of 23-47 years (mean = 29 years). There was no underlying disease of volunteers in the present study groups.

In group I (Povidone-Iodine preparation) consisted of 20 samples. The pre-preparation cultures were positive for Coagulase negative *Staphylococci*, Gram positive rod, *Acinetobacter baumannii*, *Klebsiella pneumoniae*, *Stenotrophomonas maltophila* and *Non-fermentative bacilli*. The post-preparation cultures showed positive in 5 samples. The cultures were positive for Coagulase negative *Staphylococci*, *Bacillus* spp.

In group II (Chlorhexidine preparation) consisted of 20 samples. The pre-preparation cultures were positive for Coagulase negative *Staphylococci*, Gram positive rod, *Acinetobacter baumannii*, *Stenotrophomonas maltophila* and *Non-fermentative bacilli*. The post-preparation cultures were positive for Coagulase negative *Staphylococci*, Gram positive rod. The cultures showed positive in 2 samples out of 20 samples.

There was no significant different in positive finding of bacterial cultivation ($p = 0.2$). Both antiseptics could reduce the bacterial colonization from around 35,000 colonies to below than 100 colonies. The cultivation reduction was also not significant in both antiseptic ($p = 0.068$).

Discussion

The bacterial colonization on foot, web space, nail fold and groove was commonly believed dependently on the moist of the skin[4]. The present study results showed the same pathological agent colonizing among western and tropical region when comparing with the present study of Tachibana (1976)[4]. The difference of the foot wear in tropical country did not result in the different of the pathogen colonizing. The coagulase negative *Staphylococcus* was still the most pathogen cultivated and also the highest Colony Forming Unit/mL (CFU/mL) in overall

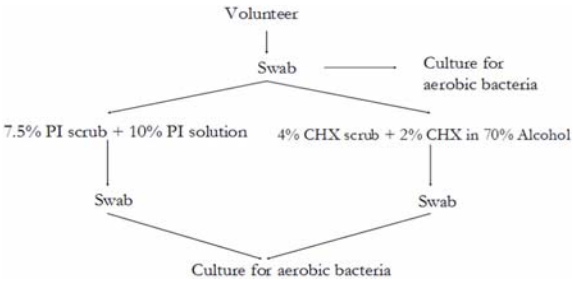

Fig. 1 Diagram showing the process of specimen collection (PI = Povidone-Iodine, CHX = Chlorhexidine gluconate)

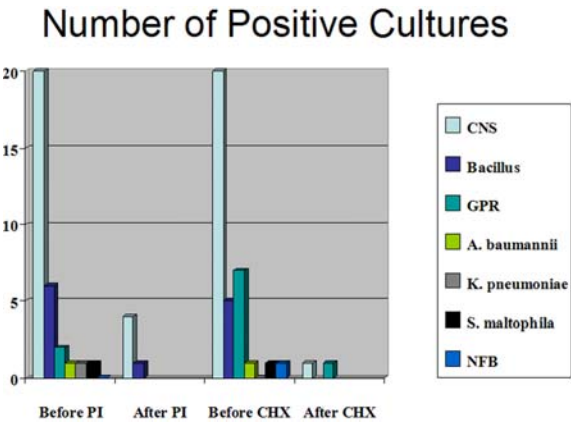

Fig. 2 Graph showing Number of positive cultures for each of the bacterial species identified before and after preparation with Chlorhexidine gluconate (CHX), and Povidone-Iodine (PI) (CNS = Coagulase negative Staphylococci GPR = Gram positive rod, A. baumannii = Acinetobacter baumannii, K. pneumoniae = Klebsiella pneumoniae, S. maltophila = Stenotrophomonas maltophila, NFB = Non fermentative bacilli)

bacteria[5]. The second most common was gram positive rod. In the present study, the authors did not evaluate other pathogen such as pathogenic protozoa, worms, fungi. To prevent the infection after surgery, the bacterial pathogen should be marked reduced as seen from the result. But the rate of positive culture was not significant different between each antiseptics. This was not the ending result for using such antiseptics in order to prevent the surgical infection. The rate of surgical infection in real situation is the key performance for the best practice, which is yet to elucidate. The type of surgery also has a role in the rate of infection such as the revision surgery which usually a greater risk of infection than primary surgery. A study by Taylor found an infection rate of 9.3% in ankle fusions and 5.8% in subtalar fusions and higher infection rate of 15.3% in revision total knee arthroplasty[6]. The Povidone-Iodine penetrate cell membrane to destroy free-sulfur amino acids cysteine and methionine, nucleotides and fatty acids inside the cell. The disadvantages of iodine compounds are tissue irritation, activity restricted to a narrow pH (~6) and greatest activity when the compound is in a dry state. Chlorhexidine crosses the cell wall or outer membrane by passive diffusion and subsequently attacks the bacterial cytoplasmic or inner membrane. Chlorhexidine resists neutralization by organic materials, is active over a wider pH (5-8) than iodine compounds and less tissue irritate. The benefit from proper selected antiseptics will provided a better medical care. In previous study showed the positive culture in Povidone-Iodine-based antibacterial scrubs in 72% after preparation[7]. The explanation for high positive rate in cultivation was the absence of second process for skin preparation with 10% Povidone-Iodine solution. Another reason is solution of the antiseptic they used has no alcohol contained, which is the best in combination with Povidone-Iodine to prevent bacterial growth[7-10]. In specific condition of foot and ankle surgery such as retention of K-wire fixation which protruded distal end out of the skin, the infection rate may be higher than no device retention. The K-wire associated colonization may be in comparison with the indwelling vascular catheter colonization which attached to the opening of skin. The present study on the effectiveness of antiseptics in prevention of infection and colonization of vascular catheter was shown the superiority of Chlorhexidine gluconate solution than Povidone-Iodine solution[1]. Another area which considered the high bacterial colonization is the vaginal opening area. The humidity in the area and the specific bacterial colonization could cause the infection after vaginal hysterectomy. The Chlorhexidine gluconate solution also showed a better result in reducing the bacterial colonization of a vaginal hysterectomy in comparison with Povidone-Iodine solution[11]. Although the results from several studies have tendency to show the high efficacy of Chlorehxidine gluconate than Povidone-Iodine, but the present study still could not conclude for which antiseptics is the best. Further investigation was needed to be done to elucidate the efficacy of each antiseptic in bacterial reduction.

Potential conflicts of interest

None.

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การเปรียบเทียบศึกษาผลของน้ำยาฆ่าเชื้อ chlorhexidine gluconate และ povidone-iodine ในการลดการปนเปื้อนเชื้อแบคทีเรียก่อนการผ่าตัดบริเวณเท้าและข้อเท้า: การศึกษานำร่อง

ลิขิต รักษ์พลเมือง, รุ่งโรจน์ ธนบดีธาดา, ก้องเขต เหรียญสุวรรณ

วัตถุประสงค์*: เพื่อประเมินผลและศึกษาความแตกต่างของกระบวนการป้องกันการติดเชื้อก่อนการผ่าตัดด้วยน้ำยาฆ่าเชื้อสองชนิด*

วัสดุและวิธีการ*: ทำการเพาะเชื้อแบคทีเรียภายหลังการทำความสะอาดด้วยน้ำยาทำความสะอาดสองชนิดคือ chlorhexidine gluconate และ povidone-iodine ในอาสาสมัครจำนวน 20 ราย*

ผลการศึกษา*: ในกลุ่มศึกษาที่ได้ใช้น้ำยาฆ่าเชื้อ povidone-iodine พบว่ามีการเพาะเชื้อขึ้นจำนวน 5 รายใน 20 ราย และพบว่าในกลุ่มศึกษาที่ใช้น้ำยาฆ่าเชื้อ chlorhexidine gluconate มีการเพาะเชื้อขึ้นจำนวน 2 รายใน 20 ราย ซึ่งจากการคำนวณทางสถิติก็ยังไม่ได้ข้อสรุปว่าสารเคมีชนิดใดมีประสิทธิภาพดีกว่าในการลดปริมาณเชื้อโรคที่บริเวณเท้า แต่การใช้สารเคมีฆ่าเชื้อเพื่อลดปริมาณเชื้อโรคก็ยังมีผลสัมฤทธิ์ในการลดจำนวนเชื้อที่พบปนเปื้อนที่ผิวหนังบริเวณเท้าและข้อเท้า*

สรุป*: ผลการศึกษายังมีข้อมูลไม่เพียงพอต่อการยอมรับว่าน้ำยาฆ่าเชื้อชนิดใดมีประสิทธิภาพดีกว่าในการลดปริมาณเชื้อโรคที่ปนเปื้อน การศึกษาเพิ่มเติมเพื่อแสดงให้เห็นความแตกต่างของน้ำยาฆ่าเชื้อแต่ละชนิดในอนาคตน่าจะมีประโยชน์ในการแสดงให้เห็นความแตกต่างมากขึ้น*