Bioelectric Silver—Zinc Dressing Equally Effective to Chlorhexidine in Reducing Skin Bacterial Load in Healthy Volunteers

Christopher L. Cooke, M.D., Renee S. Greene, B.S., Carola F. van Eck, M.D., Ph.D., Carlos Uquilas, M.D., and Orr Limpisvasti, M.D.

Purpose: The aim of the present study was to evaluate and compare the effectiveness of the silver-zinc bioelectric dressing as compared with skin preparation with 2% chlorhexidine or 4% chlorhexidine in reducing the bacterial count on the knee. **Methods:** Three groups consisting of 48 healthy volunteers were included. Age range was 23 to 54 years old and 60% of participants were male. Each subject had 1 knee serve as the test and the contralateral as the control. The test site was prepared with either 2% chlorhexidine, 4% chlorhexidine, or a silver-zinc bioelectric dressing and after 24 hours skin cultures were taken and examined for bacterial growth. **Results:** In the 2% chlorhexidine group 23 of 48 unprepped knees had positive cultures, compared with 9 of 48 prepped knees ($P = .003$; risk reduction, 4.0 times). In the 4% chlorhexidine group 25 of 48 unprepped knees had positive cultures, compared with 14 of 48 prepped knees ($P = .027$; risk reduction, 2.6 times). In the silver-zinc bioelectric dressing group 29 of 48 unprepped knees had positive cultures, compared with 7 of 48 prepped knees ($P < .001$; risk reduction, 8.9 times). There was no difference in the positive skin culture rate between the 3 methods. **Conclusions:** Application of the silver-zinc bioelectric dressing was equally effective at reducing skin bacterial load when compared with skin preparation with 2% chlorhexidine or 4% chlorhexidine in healthy volunteers. **Level of Evidence:** Basic Science − Microbiology. **Clinical Relevance:** The findings of this study indicate that the use of a bioelectric dressing after knee surgery can match the standard of care of preparing the skin with an antiseptic before surgery.

Infection after elective knee surgery is rare, but remains a feared complication in orthopaedic sports medicine. The infection rate after anterior cruciate ligament reconstruction is reported to be between 0.4% and 1.4%.[1,2]

Various factors have been associated with the risk for infection, including a history of prior surgery, obesity, diabetes, incomplete sterilization and contamination of surgical instruments, graft type, and the incomplete eradication of potentially harmful skin bacteria.[3-6] To decrease this last risk factor, various skin antiseptics have been proposed to be used before surgery.[7-11] Chlorhexidine gluconate (CHG) is a topical bactericidal that is available in various formats and remains effective for up to 24 hours.[12-14] The 2 most commonly used forms are Chloraprep One-Step (CareFusion, El Paso, TX), an applicator delivering a formula of 2% CHG and 70% isopropyl alcohol, and Hibliclens (Mölnlycke Health Care, Norcross, GA), 4% CHG solution. These products were used in the present study.

Recently a silver-zinc redox-coupled bioelectric wound dressing has been suggested to further decrease the bacterial count on the surgical site after surgery.[15,16] The silver-zinc bioelectric dressing (Jumpstart, Arthrex, Naples, FL) receives its antimicrobial properties from the micro current created by silver and zinc.[15,16] Its clinical applications include, but are not limited to, preoperative skin preparation, contaminated areas near or on the surgical site, athletic patients with a higher baseline bacterial skin count, revision surgeries, and as

From the Kerlan Jobe Orthopaedic Clinic, Los Angeles, California, U.S.A.

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Address correspondence to Christopher L. Cooke, M.D., Kerlan Jobe Orthopaedic Clinic, 6801 Park Terrace, Los Angeles CA 90045, U.S.A. E-mail: drchriscooke@gmail.com

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a postoperative dressing, as labeled by the manufacturer. The aim of the present study was to evaluate and compare the effectiveness of a silver-zinc bioelectric dressing as compared with skin preparation with 2% chlorhexidine or 4% chlorhexidine in decreasing the bacterial count on the knee.

It was hypothesized that the use of a silver-zinc bioelectric dressing would lead to a comparable decrease in bacterial flora as compared with the other 2 methods.

Methods

Institutional Review Board approval was obtained before starting the study (CR00011934/Pro00042572). The study was conducted between August 2016 and July 2017. Inclusion criteria were healthy volunteers over 18 years of age. Exclusion criteria were any open cuts, sores, or wound overlying the front of the knee or any signs of skin infection in this area.

Each group consisted of 48 healthy volunteers (age range: 23-54 years). In the 2% chlorhexidine group, 27 participants (56%) were male; in the 4% chlorhexidine group, 29 participants (60%) were male; and in the silver-zinc bioelectric dressing group, 30 participants (63%) were male. Each subject had 1 knee serve as the test and the contralateral as the control. The laterally of the test and control limb was assigned randomly. The 48 volunteers were different for each group. However, there were no baseline differences in demographics between the 3 groups. Volunteers were approached and assessed for eligibility by the first and second authors.

The 48 participants in the 2% chlorhexidine group applied this to the skin of 1 knee in a circular area of 5 inches in diameter between their tibial tubercle and the inferior pole of their patella, in the location where a bone-patellar-tendon-bone autograft harvest site incision would be placed. Participants were asked to refrain from bathing or showering for 24 hours, at which point both the skin of the test and control knee were cultured with bacterial swabs (Fig 1).

The 48 participants in the 4% chlorhexidine group applied 5 mL of the solution for at least 15 seconds to the skin of 1 knee in the same circular area of 5 inches in diameter between the tibial tubercle and the inferior pole of the patella. Participants were again asked to refrain from bathing or showering for 24 hours, at which point both the test and control knees were cultured with bacterial swabs (Fig 2).

The 48 participants in the silver-zinc bioelectric dressing group were asked to bath or shower as they usually would. Immediately thereafter, they were asked to moisten and apply a 2 × 2-inch strip of silver-zinc bioelectric dressing to the skin of 1 knee between the tibial tubercle and the inferior pole of the patella. Because the silver-zinc bioelectric dressing is not adhesive, this was then covered with a Tegaderm dressing (3M, St. Paul, MN) to hold the silver-zinc bioelectric dressing in place. After the application, the participants were told not to bathe or shower for 24 hours, at which time both knees were cultured with bacterial swabs (Fig 3).

Fig 1. Right knee showing the protocol for the 2% chlorhexidine group. The inferior pole of the patella and the tibial tubercle are marked. The 2% chlorhexidine is applied to the skin of the test knee in a circle 5 inches in diameter in between the tibial tubercle and the inferior pole of the patella.

The swabs from all subject in all groups were sent to a laboratory from an affiliated academic medical center and processed for growth of any bacterial species. Cultures were performed for bacteria only and planted on 4 different media: blood agar, MacConkey agar, chocolate agar, and Columbian blood agar. They were incubated between 35°C and 37°C and kept for 7 days. Tests were performed for both aerobic and anaerobic, and gram-positive and gram-negative species. All testing was conducted in accordance with guidelines provided by the Clinical and Laboratory Standards Institute.[17]

Statistical Analysis

A sample size calculation using preliminary data revealed a total of 48 participants were needed in each group to obtain a power of 0.9.

The difference in positive skin culture rate between knees with and without 2% chlorhexidine, 4% chlorhexidine, and the silver-zinc bioelectric dressing was calculated using the McNemar test for paired samples. The difference in positive skin culture rate between 2%