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Infection

Evaluation of the skin flora after chlorhexidine and povidone-iodine preparation in neurosurgical practice

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Abstract

Background: Currently, there are various antiseptics used for cleaning the skin before surgery, but there is no standard procedure in practice. Chlorhexidine and povidone-iodine are the most preferred compounds among antiseptics. Both are proved to be safe and effective for skin disinfection. In this study, our aim was to investigate the combined effects of chlorhexidine and povidone-iodine on the skin's flora before neurosurgical intervention, consecutively.

Methods: Randomly, 50 cranial and 50 spine neurosurgery cases were assigned to the study. The first culture was obtained after hair removal and before cleaning the skin with any antiseptic. The second culture was obtained after the skin had been cleaned with chlorhexidine for 3 minutes. Then, the skin was cleaned twice with povidone-iodine for 30 seconds, and the third and fourth cultures were taken from the skin incision area. Bacteria were identified by means of standard laboratory identification methods. Positive culture results were compared statistically among order of cultures obtained.

Results: In the first culture evaluation, 39 (33 cnS, 6 *Stapylococcus aureus*) of 50 cranial samples and 37 (33 cnS, 4 *S aureus*) of 50 spine samples showed reproduction. In the second culture, 9 cranial and 5 spine samples showed reproduction of cnS. In the third and fourth cultures, no growth was observed ($P < .001$).

Conclusion: Three minutes' cleaning of the incision area with chlorhexidine, followed by 30-second cleaning with povidone-iodine, could be a sufficient disinfection procedure for preoperative preparation of the skin in patients undergoing a neurosurgical procedure.

Keywords: Antisepsis; Chlorhexidine; Neurosurgery; Povidone-iodine; Skin disinfection

1. Introduction

Cleaning of the skin with antiseptics before the surgical intervention clearly reduces the infection risk. Currently, several methods with various antiseptics are being used for this purpose [4,10,17,18,25,26,31]. The skin cannot be entirely sterilized because approximately 20% of the resident flora is beyond the reach of surgical scrubs and antiseptics [19,30]. The aim of surgical preparation of the skin with antiseptics is to remove transient and pathogenic microorganisms on the skin surface and to reduce the resident flora to a low level. Over the years, a wide range of substances have been used in skin preparation, including phenol, tincture of iodine, surgical spirit/ethanol/isopropanol, Merthiolate, hexachlorophene, quaternary ammonium compounds, iodophor, chlorhexidine, and octenidine dihydrochloride/phenoxy ethanol [2,16,21]. Among these, chlorhexidine and povidone-iodine are most frequently preferred in institutions. Chlorhexidine is a very safe, effective, and useful antiseptic as a skin disinfectant

Abbreviations: cnS, coagulase-negative *Staphylococcus*.

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[1,12,17,21,31]. Povidone-iodine, a complex of polyvinylpyrrolidone and triiodine ions, is also widely used as an antiseptic for skin preparation [5,9,12,17,25,28,31-33]. Although both substances are generally preferred, there is still no standard procedure of using them for cleaning the skin incision area in neurosurgery practice [29,31]. In this study, our aim was to investigate the effect of chlorhexidine and povidone-iodine on the skin's flora before spinal or cranial surgical intervention, consecutively. At the same time, we wanted to determine how many times and how long would be sufficient for cleaning of the skin with chlorhexidine followed by povidone-iodine before spinal and cranial surgery.

2. Methods

This prospective study was carried out between 2002 and 2005 at the Department of Neurosurgery, University of Dicle, Diyarbakir, Turkey. Fifty cranial and 50 spinal neurosurgery cases were randomly included in the study, except for patients with an infective or open wound, immunologic deficiency disease, or diabetes. All patients took a shower 24 hours before the surgery. All samples were obtained by the same physician by using a regular cotton swab method. The first culture was obtained in the operating room immediately after shaving hairs. The second culture was obtained after the skin was cleaned with 15% chlorhexidine (Salvasol®; Turkuaz Medical, Istanbul, Turkey) by using sterile sponge for 3 minutes. Thereafter, the skin was cleaned twice with 10% povidone-iodine (Betadine®; Kansuk, Istanbul, Turkey) for 30 seconds, and third and fourth cultures were obtained after each povidone-iodine application. The samples were evaluated in the microbiology department at Dicle University. No skin reaction or allergy and postoperative infection were observed among patients.

2.1. Technique of culture

A sterile cotton swab was moistened with sterile buffered transport medium (composed of 0.075 mol/L phosphate buffer, pH 7.9; 0.1% polysorbate 80; 0.1% sodium thiosulfate; and 0.3% lecithin), and a quarter-sized area was swabbed in a circular motion, with approximately the same pressure applied when a pencil eraser is used. Each swab was placed in a vial containing 2.0 mL of the transport medium and was plated within 2 hours. Samples were diluted 10-fold with the transport medium, up to 10^{-3}, and were spread plated onto 5% sheep blood agar and eosin–methilen blue media for isolation of gram-negative rods. Plates were incubated at 37°C for 48 hours. Bacteria were identified by means of standard laboratory identification methods [3,8].

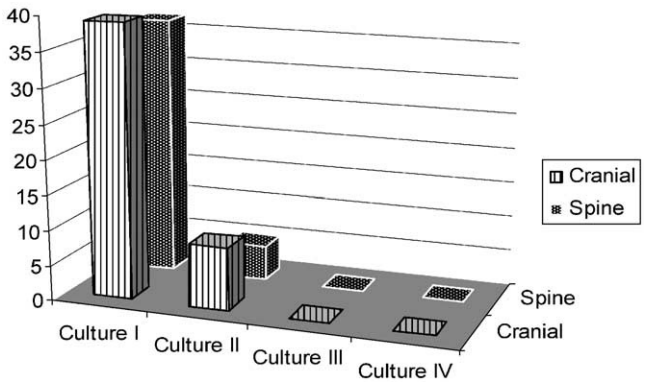

Fig. 1. Graphic showing culture results. Significant reduction of agents of skin's flora was evident after stepwise disinfection procedure.

Table 1
Growth in cultures

Region	First culture	Second culture	Third culture	Fourth culture
Cranial	39	9	–	–
Spine	37	5	–	–
Total	76	14	–	–

Both group culture results were analyzed statistically, and significant levels were determined ($P < .001$).

2.2. Statistical methods

All culture results were analyzed by Wilcoxon signed rank test, and significant levels were determined as P value less than .001. Frequencies were calculated for culture agents. Statistical analyses were carried out by using the statistical packages for SPSS 15.0 for Windows (SPSS Inc, Chicago, Ill).

3. Results

In the first culture evaluations, 39 (%78) of 50 cranial samples and 37 (74%) of 50 spine samples showed growth (Fig. 1). The second culture evaluation revealed growth in 9 (18%) cranial and 5 (10%) spine samples. The third and fourth culture evaluations did not show any growth. Both group culture results were analyzed statistically, and significant levels were determined: cranial (first and second cultures), $P < .001$); cranial (second and third cultures), $P < .001$; spine (first and second cultures), $P < .001$; and spine (second and third cultures), $P < .001$ (Table 1).

In the first culture, 33 of 39 positive cranial samples were cnS, and 6 of them were *S aureus*; 33 of 37 positive spine samples were cnS, and 4 of them were *S aureus*. In the second culture, a total of 14 samples (9 cranial, 5 spinal) showed cnS growth. Both groups' cultures were analyzed by Wilcoxon

Table 2
Agents growing in the cultures

Region	First culture agent		Second culture agent	
	cnS	*S aureus*	cnS	*S aureus*
Cranial	33	6	9	–
Spine	23	4	5	–
Total	56	10	14	–

Both groups' cultures were analyzed, and significant levels were determined ($P < .001$).

signed rank test, and significant levels were determined: cnS for cranial (first and second cultures), $P < .001$; cnS for spine (first and second cultures), $P < .001$; *S. aureus* for cranial (first and second cultures), $P < .001$; and *S. aureus* for spine (first and second cultures), $P < .001$ (Table 2).

4. Discussion

The composition of skin flora of the body varies from site to site and depends on many factors, including the amount of sebum, location of sweat glands, and moisture content. The cnS, micrococci, saprophytic *Corynebacterium* species, and *Propionibacterium* species are the predominant bacterial flora of the skin. *S aureus* regularly inhabits the external nares of approximately 30% of healthy individuals and the perineum, axillae, and toe webs of about 15%, 5%, and 2% of healthy people, respectively [2,8,13,30]. The flora of hair is similar to that of skin [27]. The skin constitutes a major source of the organisms responsible for wound infection; for this reason, the resulting prolonged suppression of skin flora might be associated with a reduction in postoperative wound infection [21]. Several studies have documented the efficacy of preoperative showers at reducing skin microbial counts [7,11,14]. All of our patients had a shower 1 day before surgery.

It was reported that chlorhexidine and povidone-iodine are useful agents for skin disinfection separately before surgery [10,14,31,33]. Chlorhexidine is a safe and effective antiseptic as a skin disinfectant, and it is more effective than povidone-iodine in diminishing skin colonization with staphylococci in patients before operation [14]. Povidone-iodine has also bactericidal activity against a wide spectrum of pathogens, including methicillin-resistant *S aureus* [6,10,22,27,29]. No adverse effects such as skin reaction or allergy and postoperative infection were observed in any patients in the presented study.

Although many researchers agree that chlorhexidine and povidone-iodine are effective antiseptics [31], there is no certain duration of application for the antiseptic effect.

Comparing the effectiveness of a 2-, 4-, and 6-minute surgical scrub on the hand bacterial colony count using chlorhexidine (4% solution), O'Shaughnessy et al [27] have reported that scrubbing for longer than 2 minutes does not confer advantages for reducing hand bacterial colony counts, although they used a lower concentration of chlorhexidine solution than what was used in our study.

Comparing the effect of chlorhexidine and chlorous acid on presurgical skin flora, Aly et al [1] have found out that the chlorous acid product has the practical advantages of a shorter scrub time, less foam, air drying, and no perceivable residue. In comparison with chlorhexidine, the chlorous acid presurgical skin preparation produced superior but statistically equivalent reductions of each volunteer's normal flora at 10 minutes, 30 minutes, and 6 hours after treatment.

Moen et al [25] compared povidone-iodine spray and traditional scrub-paint techniques for reducing abdominal wall bacteria during preoperative preparation. Cultures of the abdominal skin were performed before and after preparation with 2 techniques: a traditional 5-minute iodophor soap scrub paint on one half and povidone-iodine aqueous spray on the other. They recorded the mean number of colonies for spray after 1 minute, for spray after 3 minute, and after 5-minute scrub. In the both techniques, the spray after 3 minute and the 5-minute scrub were statistically more effective at reducing bacterial counts than the spray for 1 minute. It has also been shown that povidone-iodine applied as a spray and left to dry for 3 minutes appears to be as effective as the traditional scrub-paint technique in reducing abdominal wall bacteria before abdominal surgery. Langgartner et al [15] have reported that skin disinfection with propanol/chlorhexidine followed by povidone-iodine was superior in the prevention of microbial central venous catheter colonization compared with either of the regimens alone. Despite the fact that combinations of chlorhexidine and alcohol have generally been shown to be more efficient when compared with povidone iodine in some studies, there is no combined study of povidone-iodine and chlorhexidine for skin disinfection of the incision area in neurosurgery patients in the literature [20,23,24]. Therefore, in this study, these 2 disinfectants were preferred consecutively for skin disinfection before surgery.

In conclusion, the presented study showed that using a combination of chlorhexidine with povidone-iodine is safe and effective for skin antisepsis, and preoperative surgical skin area scrubbing with chlorhexidine 3 minutes, followed by cleaning once with povidone-iodine, could be enough for reducing skin bacterial flora before neurosurgical intervention. This practice may provide a standard skin disinfection method in neurosurgical procedures.

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Commentary

The most important preventive measure of surgical wound infection is operating room asepsis and preparation of the surgical site. Ushered in by Louis Pasteur in 1862 and Joseph Lister 3 years later, the implications of antisepsis were immediately appreciated and developed. For the first time in recorded history, major surgical procedures were performed with reasonable expectations that wound healing and recovery would ensue. The introduction of prophylactic antimicrobial therapy in the late 1940s even further reduced surgical wound infection. Today, neurosurgical wound sepsis after spinal surgery varies from 0.75% to 3%.

Nevertheless, surgical infection can still be further reduced. Because an inoculum as small as 10 microorganisms per milliliter can cause fulminating infection in vertebral discs in rabbits, efforts should be made to totally microbiologically cleanse the skin preoperatively. Guzel et al present evidence that the sequential use of chlorhexidine for 3 minutes followed by 2 applications of povidone-iodine for 30 seconds resulted in sterilization of the skin by culture on both 5% sheep blood and eosin–methylene blue agar taken on 2 poststerilization cultures. The study included 50 patients with cranial and 50 patients with spinal surgery between the years 2002 and 2005. Seventy-eight percent and 72% of the presterilization cultures grew out of a variety of skin contaminants from cranial and spinal samples that included coagulase-negative staphylococci and *Staphylococcus aureus*, common bacterial causes of postoperative surgical wound sepsis.

Using this sterilization program may further reduce the incidence of neurosurgical wound sepsis. The authors also suggest that a single povidone-iodine sterilization program may be as effective.

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