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ORIGINAL ARTICLE

Topical benzoyl peroxide application on the shoulder reduces *Propionibacterium acnes*: a randomized study

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Background: *Propionibacterium acnes* is a common cause of infection following shoulder surgery. Studies have shown that standard surgical preparation does not eradicate *P acnes*. The purpose of this study was to examine whether topical application of benzoyl peroxide (BPO) gel could decrease the presence of *P acnes* compared with today's standard treatment with chlorhexidine soap (CHS). We also investigated and compared the recolonization of the skin after surgical preparation and draping between the BPO- and CHS-treated groups.
Methods: In this single-blinded nonsurgical study, 40 volunteers—24 men and 16 women—were randomized to preoperative topical treatment at home with either 5% BPO or 4% CHS on the left shoulder at the area of a deltopectoral approach. Four skin swabs from the area were taken in a standardized manner at different times: before and after topical treatment, after surgical skin preparation and sterile draping, and 120 minutes after draping.
Results: Topical treatment with BPO significantly reduced the presence of *P acnes* measured as the number of colony-forming units on the skin after surgical preparation. *P acnes* was found in 1 of 20 subjects in the BPO group and 7 of 20 in the CHS group ($P = .044$). The results remained after 2 hours ($P = .048$).
Conclusion: Topical preparation with BPO before shoulder surgery may be effective in reducing *P acnes* on the skin and preventing recolonization.
Level of evidence: Level I; Randomized Controlled Trial; Treatment Study

Keywords: *Propionibacterium acnes*; preoperative shower; shoulder; infection; benzoyl peroxide; chlorhexidine

Propionibacterium acnes is a gram-positive facultative anaerobic rod and a human commensal bacterium that resides in the pilosebaceous ducts of the skin.[1,6] The reported number of shoulder infections after surgery caused by *P acnes* is increasing, as is the incidence of resistance to antibiotics.[1,3,11,16,21,26]

Ethical committee approval was received from Linköping Ethical Vetting Secretariat (Study No. 2014/485-32).

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The ability of *P acnes* to create biofilm causes severe infections that may involve reoperation and long-term antibiotic treatment. To decrease the bacterial burden on the skin before an operation, one strategy is topical preparation at home with chlorhexidine soap (CHS). Despite strict preoperative preparation with chlorhexidine solution in 70% ethanol, earlier studies have shown that chlorhexidine is not able to eradicate *P acnes* from the skin. From 7% up to 50% of *P acnes* may still be present on the skin.[10,15,23,25] Benzoyl peroxide (BPO) is widely used as topical therapy for acne vulgaris and has been for more than 5 decades. The bactericidal effect of BPO on *P acnes* is well documented and has not been associated with the development of *P acnes* resistance.[4,8,12,17] The purpose of this study was to examine whether topical application of BPO could decrease the presence of *P acnes* on the treated skin compared with today's standard treatment with CHS. We also investigated and compared the recolonization of the skin after surgical preparation and draping between the BPO- and CHS-treated groups.

Material and methods

In this single-blinded nonsurgical randomized study, 40 healthy volunteers aged 20 to 66 years, comprising 24 men and 16 women, gave informed consent to participate. The exclusion criteria were antibiotic treatment 10 days prior to the trial day, diabetes mellitus, local skin lesions, and local or systemic corticosteroid treatment. The participants were randomized in blocks of 4 to CHS or BPO pretreatment. The investigator was blinded to the allocated treatment. One week prior to the trial day, the participants received verbal and written instructions. Thereafter, the first skin swab was collected on the left shoulder (sample A).

The BPO and CHS groups underwent preparation as follows: (1) The treatment setup in the BPO group was designed in collaboration with a dermatologist, who advised on drug concentration and application frequency to minimize local side effects, such as erythema, peeling, and dryness. Hence the BPO group started the procedure 48 hours before the trial day. After showering, the participants applied a 5-cm strip of 5% BPO on dry skin on the left shoulder twice that day. They repeated the application the following morning and evening. The fifth, and last, application occurred in the morning on the trial day. (2) According to the local routine protocol, the CHS group underwent preparation with 4% CHS on the left shoulder, starting the day before the trial day with 2 showers, with a minimum of 2 hours between them, using 2 sponges each, and on the trial day, with 1 shower in the morning, using 2 more sponges.

A treatment diary was administered to each participant for affirmation of each gel application or shower, showing 100% compliance. On each trial-day occasion, 4 volunteers were placed in separate beds in the same operating room with laminar airflow (LAF) with their upper body inside the LAF circle. Before surgical preparation, the next skin swab was collected from the treated left side (sample B). At the same time, a control swab was taken from the contralateral shoulder. Another skin swab was collected after the treated left side was prepared for 2 minutes with 0.5% chlorhexidine solution in 70% ethanol, and a sterile drape was applied (sample C). Finally, 120 minutes after surgical preparation and sterile draping, the last skin swab was collected (sample D) (Table I). All skin swabs were taken by rubbing 15 times over a 10-cm deltopectoral interval and were immediately put into the medium. Within 30 minutes, the skin swabs were transported to the laboratory, vortexed for 10 seconds before being cultured in anaerobic blood agar medium without antibiotics, and placed in an anaerobic incubator. After 5 days in the incubator, we counted the numbers of colony-forming units (CFUs) and divided these data into 5 groups (Table II). The bacterial colonies were classified on agar plates by surface characteristics. *P acnes* was identified with matrix-assisted laser desorption/ionization time-of-flight mass spectrometry. Analyses were blinded and performed by the first author. The code was broken after analyses were performed.

Table I Skin swab collection times

	Time
Sample A	Before treatment, 1 week before trial day
Sample B	Trial day, after topical treatment at home
Sample C	After surgical preparation and sterile draping
Sample D	120 min after surgical preparation and sterile draping
Control (untreated right shoulder)	Trial day

Table II Grouping of CFUs

	Group 0	Group 1	Group 2	Group 3	Group 4
CFUs	0	1-15	16-100	100-999	≥1000

CFUs, colony-forming units.

Statistical analysis

We used the Fisher exact test for dichotomous variables; otherwise, the χ^2 test. $P < .05$ was considered statistically significant.

Results

Before any treatment (sample A), *P acnes* was detected in 38 of 40 subjects, and there was no significant difference in the number of CFUs between the groups. The presence of *P acnes* diminished with treatment in the BPO group (Fig. 1, *A*) but not in the CHS group (Fig. 1, *B*). After skin preparation (sample C), we could detect CFUs of *P acnes* in only 1 of 20 subjects in the BPO group compared with 7 of 20 in the CHS group ($P = .044$, Fig. 2). Two hours later, the BPO group showed a significantly lower *P acnes* presence than the CHS group ($P = .048$, Fig. 2). There was no significant difference in the presence of *P acnes* before surgical field preparation (sample B) and after 2 hours (sample D) in the CHS group (Fig. 1, *B*), in contrast to the BPO group (Fig. 1, *A*). The total number of CFUs (which might comprise more bacterial strains than *P acnes*) diminished after topical treatment in the BPO group ($P = .035$) but not in the CHS group ($P = .284$).