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Is there value in the routine practice of discarding the incision scalpel from the surgical field to prevent deep wound contamination with *Cutibacterium acnes*?

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Background: *Cutibacterium acnes* is found in skin flora of the shoulder and is the most common microbe identified in periprosthetic shoulder infections. The purpose of this study is to determine if there is *C acnes* present on the incision scalpel in patients undergoing shoulder arthroplasty despite extensive skin preparation techniques to prevent wound contamination.
Methods: The authors collected a consecutive case series of patients meeting inclusion criteria. Patients were included if they underwent either primary or revision shoulder arthroplasty at the tertiary care hospital with the senior author during the study period. Culture swab samples, testing for presence of *C acnes*, were collected from 17 consecutive patients who underwent shoulder arthroplasty with a single fellowship-trained surgeon between November 2019 and March 2020. Culture reports were recorded as ''positive'' or ''negative'' after 21 days. Institutional review board approval of the study protocol was obtained. The null hypothesis was that there would be no cases with knife blades ''culture positive'' for *C acnes*.
Results: 17 patients were identified and fit inclusion criteria. There were 12 men (mean age 64.3 years, range 48-79 years) and 5 women (mean age 69.8 years, range 59-79 years). Two patients (11.8%) were found to have *C acnes* growth on the skin knife. Both patients were male and older than 70 years undergoing primary reverse shoulder arthroplasty with no history of previous shoulder infections.
Conclusion: The presence of *C acnes* on the skin blade in 2 patients validates concerns that there is *C acnes* present in dermal tissue despite extensive attention to eradication of these microbes. There was a high rate of *C acnes* contamination on scalpel blades used for initial skin incisions and the authors conclude that there is value in discarding these blades from the surgical field.
Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Shoulder; infection; *C acnes*; arthroplasty; scalpel

Infection following shoulder arthroplasty is a catastrophic outcome, occurring in 1%-19% of primary, and approximately 15% of reported revision cases.[13,18,24] Infection with *Cutibacterium acnes*[4,17,23] represents a significant portion of these infections.[6,14,18,19,26] *C acnes* is a frequent culprit in patients with chronic periprosthetic infections in particular.[9,13,26] *C acnes* is a gram-positive,

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anaerobic bacillus that is a common skin flora, found in areas of the body with sebaceous pores of the skin.[1] Specifically, the area around the shoulder is known to have greater concentrations of *C acnes* than other parts of the body, particularly in male patients.[3,16]

Previous work has identified the presence of *C acnes* in the skin of patients undergoing open shoulder surgery.[18,26] *C acnes* has been demonstrated to be the most common microbe identified in patients with periprosthetic shoulder infections.[13] Although the skin is commonly noted to be the area of concern for *C acnes* infection, recent work has found the microbe to be cultured from deeper within surgical wounds as well.[26] The ubiquity of *C acnes* throughout the soft tissues of the shoulder, particularly in the skin and subcuticular layers, has raised concern among shoulder surgeons, especially when performing arthroplasty. Given rates and consequences of periprosthetic infections, orthopedic surgeons have emphasized preoperative eradication of skin flora, notably *C acnes*, from the dermal layers via skin prep and intravenous antibiotic usage. Standard skin prep solutions (eg, chlorhexidine gluconate, betadine soap) in addition to solutions specifically targeted to eradicate *C acnes* (eg, hydrogen peroxide, benzoyl peroxide, and intraoperative vancomycin powder) are commonly used; however, no consensus exists regarding a standardized protocol.[2,3,8,11,15,20,25] Despite these multifaceted approaches to prevention, periprosthetic infections with *C acnes* have persisted and remain a significant challenge.[21]

The authors propose this study as a pilot work to identify the potential presence of culture-identifiable *C acnes* present on the scalpel blade used for initial skin incision despite exhaustive skin prep protocols to eradicate them. Presence of the microbe on any skin blades raises the concern for intraoperative contamination and subsequent infection, and the need for evaluation of preoperative and perioperative practice to prevent infection. The authors hypothesize that there will be evidence of *C acnes* present in a small subset of patients' skin blade culture samples.

Materials and methods

Consecutive patients meeting inclusion criteria were collected for analysis. Culture swab samples testing for presence of *C acnes* were obtained from 17 consecutive patients who underwent shoulder arthroplasty with a single fellowship-trained surgeon between November 2019 and March 2020; no patients undergoing arthroplasty during the study period were excluded from data collection. Because of the COVID-19 Pandemic, all elective surgical cases were stopped in March 2020. As a result of this break, the authors elected to analyze the data.

Patients were included in the analysis if they underwent either primary or revision shoulder arthroplasty with the senior author during the study period. Patients undergoing any nonarthroplasty procedure were excluded from data collection. Patient demographic information was gathered, as well as procedure details (Table I).

As is standard at the authors' institution, patients performed 4% chlorhexidine gluconate solution, Hibiclens (Molnlycke Health Care US, LLC, Nocross, GA, USA) scrubs of the surgical area at home 48 hours before, 24 hours before, and on the morning of surgery during showers for 5 minutes per shower. On the day of surgery, patients had any hair in the planned surgical field removed with a battery-powered clipper. Intravenous antibiotics (1 g cefazolin and 1 g ceftriaxone[10], pending patient allergies) were initiated within 1 hour of incision. An interscalene block was performed following a preprocedure scrub with 2% chlorhexidine gluconate prep. Patients were then brought back to the operating room and were transferred to the operating table and placed in a modified beach chair position. Following anesthesia induction with an endotracheal tube, patients underwent final positioning. Next, antiseptic prep was performed in the standard fashion starting first with hydrogen peroxide-soaked gauze, followed by 2 chlorhexidine gluconate and 70% isopropyl alcohol prep sticks in an effort to eradicate *C acnes* from the skin surface.[11,25] Standard draping was performed, including a layer of Ioban (3M, St Paul, MN, USA) over the entire surgical site, covering all exposed skin, prior to incision.[12,15] All members of the surgical team wore surgical hoods. A planned incision was marked out, WHO standard time-out performed, and an incision was made with a no. 10 blade scalpel. Immediately following skin incision through the subcuticular layer of skin, the blade was placed off the surgical field, and a culture swab was performed. (Fig. 1) Cultures were sent with specific instruction to test for *C acnes*, and subsequently held for 21 days before final reading. Patients underwent the duration of the operation with standard protocol. One gram of vancomycin powder was rubbed into the subcutaneous layer at the initial incision time and at the conclusion of the procedure prior to skin closure. All patients had wounds irrigated with chlorhexidine gluconate solution, 0.05%, Irricept (Irrimax; Innovation Technologies Inc., Lawrenceville, GA, USA) intraoperatively before implantation of hardware.

Culture swabbing for the presence of *C acnes* was performed as a safety protocol implementation by the senior author to determine the potential presence of the microbe in these patients' surgical wounds. Performing these culture analyses has become the author's standard of care.

Culture swabs were taken directly to the microbiology lab where they were cultured with thioglycolate broth and anaerobic blood agar (CDC); in 3 plates, cultures were checked for growth

Table I Demographic and surgical data

Factor	Data
Age, yr	65.9 ± 9.5
Sex	
Male	12
Female	5
BMI	27.0 ± 5.9
Procedure	
Primary RTSA	10
Revision RSTA	4
Antibiotic spacer	2
Primary TSA	1

BMI, body mass index; *RTSA*, reverse total shoulder arthroplasty; *TSA*, total shoulder arthroplasty.

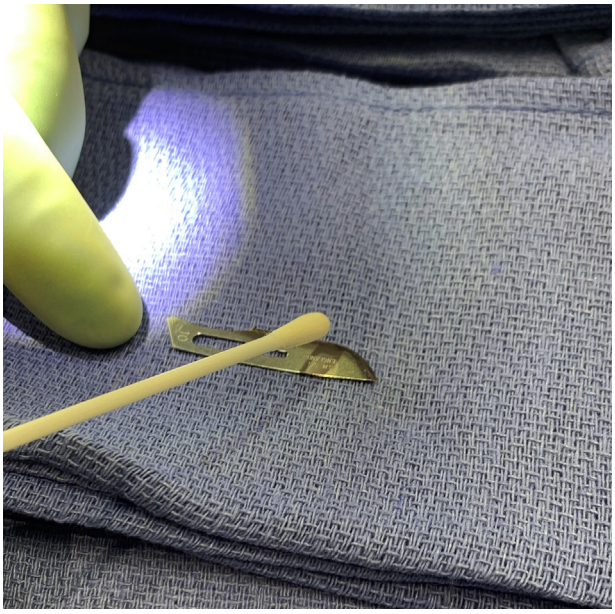

Figure 1 Swab of skin blade for culture.

on a daily basis. After 21 days of incubation (or sooner for positive tests), results were recorded for the *C acnes* culture test as positive, or negative. Patients were informed of the results of their *C acnes* cultures at their routine follow-up visits. There was no change in postoperative protocol based on these results. Patients were informed that the potentially microbe-carrying knives were ''thrown off'' the field prior to deepening of incision.

Results

In total, 17 consecutive patients undergoing shoulder arthroplasty with the senior author were identified and fit inclusion criteria for this study. No patients were excluded from analysis for any reason. There were 12 men (mean age 64.3 years, range 48-79 years) and 5 women (mean age 69.8 years, range 59-79 years). Eleven cases were for primary arthroplasty (10 reverse total shoulder arthroplasty and 1 anatomic total shoulder arthroplasty), and 6 cases were for revision arthroplasty (3 as part of 2-stage revision procedures). Four patients had a history of previous ipsilateral shoulder infection and were undergoing revision surgery (2 second-stage revisions of antibiotic spacer to reverse total shoulder arthroplasty; 1 first-stage revision, explant of total shoulder arthroplasty to antibiotic spacer; and 1 single-stage revision from total shoulder arthroplasty to reverse total shoulder arthroplasty). One of these 4 patients had prior history of documented *C acnes* infection. None of these patients were found to have evidence of *C acnes* on skin knife culture in the current study.

Two patients (11.8%) were found to have *C acnes* growth on the skin knife. One patient was a 73-year-old man undergoing primary reverse total shoulder arthroplasty, with no previous history of shoulder infection. The procedure was uncomplicated, and the patient had an uneventful postoperative course. The second patient is a 72-year-old man undergoing a primary reverse total shoulder arthroplasty, with no previous history of shoulder infection; this procedure was also uncomplicated with a typical postoperative course.

Discussion

In the present study, the authors describe 2 cases among 17 patients (11.8%) with *C acnes* cultured on the incision blade. Identification of even a single positive result, despite efforts including current skin preparation techniques to minimize wound inoculation with *C acnes*, warrant further discussion of the implications of these findings as they relate to wound infections. The authors had initially planned to sample significantly more patients in an effort to eliminate potential for selection bias, but elective cases were halted during the collection period due to the COVID-19 pandemic. This study identified the presence of *C acnes* contamination on a proportion of scalpels after the initial incision and concludes that there is value in discarding the blade from the surgical field.

Though it is often difficult to prove the source of infection, *C acnes* has been identified as the microorganism of interest in many patients with periprosthetic infections.[6,13] A recent study by Torrens et al identified *C acnes* in 18.8% of patients undergoing primary reverse total shoulder arthroplasties, via intraoperative soft tissue culture.[26] The work of the current study underscores the widespread prevalence of *C acnes*, present in greater than 10% of patients in the small cohort, despite a thorough protocol to eradicate the microbe from the surgical field (extensive preoperative and intraoperative skin scrub, including hydrogen peroxide). However, the authors do caution that more work must be done to correlate the rate of skin blade contamination with deep wound infections.

There is significant described variation of skin preparation with antiseptic to prevent deep infection with *C acnes.* Skin cleansing in the day(s) prior to surgery varies widely. Immediate preoperative scrub routines vary significantly as well. Prep of the shoulder has increasingly focused on eradication of *C acnes*. Chlorhexidine gluconate scrub, iodine preps, 2% chlorhexidine–70% isopropyl alcohol, and the recent attention of adding hydrogen peroxide or benzoyl peroxide (to specifically target *C acnes*) have been described.[3,7,20,25] In addition, perioperative intravenous antibiotics, including cefazolin, ceftriaxone, vancomycin, and doxycycline, as well as vancomycin powder (intraoperatively), are administered but have varying degrees of published success.[3,8-10,18,19] Lee et al have indicated the inadequacy of chlorhexidine prep alone in eradicating dermal layers of *C acnes*.[11] Given the persistence of *C acnes* despite antibiotics and skin scrub, Hsu has suggested

specific attention to implant handling (avoiding dermal contact) and maximizing other methods of maintaining sterility.[9]

The senior author employs a strategy of routinely discarding the knife used for skin incision immediately after first incision. Though the current study does not have measurable outcomes regarding the efficacy of this practice, we feel this strategy serves 2 purposes. First, as demonstrated by the positive skin blade results in this study, there is measurable *C acnes* present on the knife following incision, which could then contaminate the deep wound. Second, and perhaps equally as important, the senior authors feel that discarding this knife "sets a tone" for the entire operating room of increased attention to sterile technique. When the knife is discarded, a message is conveyed to everyone present that extra attention is being paid to preventing infection. Though this is difficult to quantify, the authors believe this is influential to preventing subsequent infections. Previous works have examined the practice of discarding the "skin knife," and have had mixed recommendations.[5,22] More recent work by Schindler recommends discarding the initial knife given the cost-benefit assessment of the practice vs. deep wound infection.[22] In arthroplasty cases, all efforts must be made to minimize the chance of infection.

Limitations of the study include the small sample size. However, it should be noted that the important, and somewhat unexpected, results of the study underscore the need to present this data prior to enrolling more patients over a longer time period. Additionally, cultures were not taken of the skin prior to incision, during implantation, or closure.

Conclusions

Though increasing attention has been paid to eliminating *C acnes* from the surgical field, it continues to be a significant cause of periprosthetic shoulder infections. The presence of *C acnes* on the skin blade in patients from this study supports the notion that the microbes remain on the skin/subcutaneous tissue at the time of incision. The authors found a high rate of *C acnes* contamination on scalpels after initial incision and conclude that there is value in discarding the skin knife from the surgical field.

Disclaimer

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