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ORIGINAL ARTICLE

Prevalence of *Propionibacterium acnes* in the glenohumeral compared with the subacromial space in primary shoulder arthroscopies

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Hypothesis: We hypothesized that the prevalence of *Propionibacterium acnes* in patients undergoing primary shoulder arthroscopy is equal in the glenohumeral space compared with the subacromial space.

Methods: Patients aged 18 years or older with shoulder arthroscopies were included. The exclusion criteria were prior shoulder operations, complete rotator cuff tears, systemic inflammatory diseases, tumors, shoulder injections within 6 months of surgery, and antibiotic therapy within 14 days preoperatively. After standardized skin disinfection with Kodan Tinktur Forte Gefärbt, a skin swab was taken at the posterior portal. Arthroscopy was performed without cannulas, prospectively randomized to start either in the glenohumeral space or in the subacromial space, with direct harvesting of a soft-tissue biopsy specimen. Sample cultivation was conducted according to standardized criteria for bone and joint aspirate samples and incubated for 14 days. Matrix-assisted laser desorption–ionization time-of-flight spectrometry was used for specimen identification in positive culture results.

Results: The study prospectively included 115 consecutive patients with normal C-reactive protein levels prior to surgery (54.8% men; mean age, 47.2 ± 14.6 years). *P acnes* was detected on the skin after disinfection in 36.5% of patients, in the glenohumeral space in 18.9%, and in the subacromial space in 3.5% ($P = .016$).

Conclusion: The prevalence of *P acnes* is significantly higher in the glenohumeral space compared with the subacromial space in primary shoulder arthroscopies. The results do not confirm the contamination theory but also cannot clarify whether *P acnes* is a commensal or enters the joint hematologically or even lymphatically or via an unknown pathway. Despite standardized surgical skin disinfection, *P acnes* can be detected in skin swab samples in more than one-third of patients.

The Ethical Committee of the medical faculty of the University of Düsseldorf granted approval for this prospective trial. The study was registered at the German Clinical Trials Register (DRKS) (registration number DRKS00007935). Written informed consent was obtained from all subjects.

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Propionibacterium acnes is an anaerobic aerotolerant, gram-positive rod and commensal of the human skin microflora. It is found predominantly in hair follicles and the subcutis and more frequently on the shoulder than in the knee or hip region.[26,27] In vitro studies have shown that *P acnes* strains are able to form biofilms and that the biofilms seem to play a role in making antibiotic therapy less effective.[5]

P acnes is a facultative pathogenic bacterium and is associated with various complications in orthopedic surgery, predominantly low-grade infections in total shoulder arthroplasty (TSA).[3,14,19,24] Pottinger et al[29] reported that, in their series of 193 revision TSAs with a total of 108 positive culture results, *P acnes* was identified in 70%. Topolski et al[37] identified *P acnes* in 42 of 72 TSA revisions (62%).

P acnes infections often demonstrate an indolent clinical course, lacking the obvious signs of a joint infection.[6,10,23] For culturing of anaerobic bacteria, some features have to be considered: appropriate transport medium, short transportation time to the laboratory, performance of anaerobic culture, and need for several culture media including enrichment broths and a prolonged incubation time.[2,6,21]

Recent studies have revealed a high incidence of positive *P acnes* culture results in up to 43% of patients undergoing primary TSA or primary open shoulder surgery.[12,15,18,22] These results led to the current discussion of whether *P acnes*–positive culture results from the joint are a result of colonization of the glenohumeral joint, contamination by the surgical approach, or a valid but occult bacterial infection.[12] Levy et al,[18] who detected *P acnes* in the joint fluid and tissues of 23 of 55 consecutive patients (41.8%) undergoing primary TSA, even hypothesized that *P acnes* might be involved in the pathogenesis of idiopathic glenohumeral osteoarthritis. In contrast to these results, Maccioni et al[20] identified *P acnes* in deep tissue samples of only 3 of 32 patients undergoing primary TSA and concluded that positive *P acnes* culture results in primary shoulder surgery are predominantly caused by contamination via the surgical approach.

Regarding skin colonization, *P acnes*–positive culture results can be found in up to 70% of patients[17] even after surgical disinfection. However, to date, the prevalence of *P acnes* in the glenohumeral space has not been compared with the subacromial space divided by the intact rotator cuff.

The major goal of this prospective, explorative, randomized trial is to compare the detection of *P acnes* in the glenohumeral versus subacromial space in primary shoulder arthroscopies with an intact rotator cuff. Furthermore, we aimed to re-evaluate the persistence of *P acnes* on the skin after standard surgical disinfection. The hypothesis was that the prevalence of *P acnes* would be equal in both separated joint compartments, confirming the theory of contamination through the surgical approach.

Methods

This prospectively randomized clinical study included 115 consecutive patients aged 18 years or older with an intact rotator cuff undergoing primary shoulder arthroscopy for various pathologies. The indications for surgery were as follows: long head of the biceps tenodesis or tenotomy, superior labrum anterior-posterior tear repair, acromioclavicular joint resection, subacromial decompression, subacromial bursectomy, subscapularis tendon repair, 270° capsular release for adhesive capsulitis, labral reconstruction for shoulder instability, deposit removal and débridement for calcific tendinitis, and suprascapular nerve decompression. Patients with systemic inflammatory diseases or tumors, as well as patients who had received subacromial or glenohumeral injections within 6 months before surgery, were excluded from this trial. In addition, patients who underwent antibiotic treatment within the last 14 days before surgery were not included. Finally, patients with an intraoperative diagnosis of a full-thickness tear of the supraspinatus tendon, not diagnosed during the preoperative imaging or clinical examination, were excluded.

Surgical technique and intraoperative sampling

A total of 2 samples were collected from all patients. Shoulder arthroscopy was performed either with standard beach-chair positioning of the patient with elbow flexion of 90° and neutral glenohumeral rotation or with lateral decubitus positioning for the treatment of glenohumeral instabilities with the arm in 45° of abduction. In all patients, surgery and sample collection were conducted by the first author.

Surgical disinfection was conducted by wiping the skin with 6 consecutive sterile swabs (gauze, 100% cotton; Lohmann & Rauscher, Neuwied, Germany) soaked in 100 mL of alcoholic disinfectant (Kodan Tinktur Forte Gefärbt [45.0 g of 2-propanol, 10.0 g of 1-propanol, 0.20 g of biphenyl-2-ol]; Schuelke & Mayr, Norderstedt, Germany). After disinfection for at least 5 minutes, the first sample was taken from the skin at the location of the planned incision for the posterior portal, approximately 1 cm below and medial to the lateral acromial edge, using a flocked swab (ESwab; Copan Italia, Brescia, Italy).

Arthroscopy was performed with the patient in the beach-chair or lateral decubitus position and started with a standard posterior camera portal (Fig. 1). Whether the subacromial space or the glenohumeral joint was entered first was preoperatively prospectively randomized using sealed envelopes. After the glenohumeral joint was filled with saline fluid, an anterior working portal above the subscapularis tendon was created, and immediately, a biopsy specimen from the synovial tissue in the lower recess was taken using closed Johnson jaws grasper forceps. In the saline fluid–filled subacromial space, a lateral working portal was created, and a biopsy specimen