Title:

Closure After Total Shoulder Arthroplasty: Subcuticular Closure with 2-Octyl Cyanoacrylate Versus 2-Octyl Cyanoacrylate With A Self-Adhering Mesh (Dermabond Prineo)

Authors:

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Rationale and Context:

Despite the increasing incidence of total shoulder arthroplasty surgeries, including conventional and reverse arthroplasties, little has been published regarding adequate closure of the wounds, including acceptable scar formation.

Background:

Shoulder arthroplasty, both conventional total shoulders and reverse total shoulders have been increasing in frequency in the United States. With over 2/3 of shoulder arthroplasties being performed in patients over the age of 65 and the FDA approval of the reverse shoulder in 2003, the number of shoulder arthroplasties has been growing faster than ever [1]. With amplified attention to shoulder arthroplasty, numerous advancements in prosthetics and surgical technique have recently been developed. However, very few studies have evaluated the process of total shoulder closure techniques and its relationship to quality of outcome regarding complications and aesthetics.

As newer methods of wound closure have been developed, the field of orthopaedic surgery has been slowly adapting, accepting alternative techniques in an attempt to improve cost and clinical outcomes such as decreased drainage, faster closures, and greater cosmetic appeal / patient satisfaction. Medical grade cyanoacrylates have been increasingly used for medical wound closures, such as 2-Octyl Cyanoacrylate (OCA), commonly referred to by its marketed name of Dermabond®. Orthopaedic surgery, plastic surgery, general surgery, etc. have been using this project over the past few years as an augment to wound closure. Numerous studies have looked at the use of dermabond in wound closure and have found benefits such as decreased surgical time, improved patient satisfaction, less wound drainage, and no difference in closing strength, scar appearance, or other complications [2-5]. Additionally, previous studies have demonstrated that Dermabond® has antimicrobial effects, being bactericidal to both gram positive and gram negative bacteria, including MRSA, E. coli, and S. epidermidis [6, 7].

As total shoulder arthroplasty procedures increase, the incidence of prosthetic joint infection has been rising as well, most recently at 0.8-1.46% of surgeries [8]. Closure with staples has been associated with a higher risk of wound infection, and currently, there is no standard closure for total shoulder arthroplasty, though a layered closure with OCA topical adhesive has been recommended [8]. In the orthopaedic literature, the use of

OCA as an adjunct to wound closure has been more heavily evaluated in the joint reconstruction and trauma literature, especially for total knees and hips. When evaluating total knee arthroplasty utilizing OCA, Krebs et al showed it to be a faster technique of closure with no significant difference in length of stay or complications [9]. El Gazaar showed less wound drainage in total knees that used dermabond as an adjunct to wound closure with staples [10]. Total hip arthroplasty has also showed benefit when using OCA. Glennie et al showed than when using monocryl and dermabond versus staples for total hip closures, there was no significant difference in scar assessment, shorter time to closure, shorter hospital stay, and similar total cost [11]. Mudd et al looked at trauma patients after Kocher-Langenbach approaches closed with monocryl and dermabond versus staples, and found that the dermabond group had a shorter time until a dry incision, fewer post-op infections, and shorter time in the operating room that saved an average of $900 per surgery [12].

A new closure technique of OCA closure using a self-adhering mesh (Dermabond Prineo®) was developed that further decreased operative times and had similar outcomes. Parvizi et al showed benefits including that patients could shower immediately, could be removed easily with less pain after healing, forms a microbial barrier, provides even tension distribution across the wound, and reduced subcutaneous closure time compared to monocryl with steri strips [13]. Additionally, since the time in the operating room was less, the Prineo was found to be overall less expensive [13]. Richter et al also showed that while Prineo provided equivalent skin approximation compared to intradermal sutures, it was 4.5 times faster to apply and resulted with similar incision healing and cosmetic outcomes [14]. With positive results seen in the literature, Prineo dressings have been increasingly used in total hip and knee replacements. Holte et al evaluated a 2.5 year period with 360 consecutive primary total knees by one surgeon and showed that use of Prineo was successful for high tension total knee wounds, with no cases of wound dehiscence, operative intervention, or prosthetic joint infection [15]. Sutton evaluated the cost-effectiveness of Prineo compared to skin staples and found that Prineo was associated with a shorter length of stay, fewer discharges to rehab, and lower rates of all-cause readmission [16].

The goal of this study is to compare conventional methods of wound closure after total shoulder arthroplasty, such as monocryl and dermabond, to a OCA mesh closure technique and evaluate its success.

Objective and Hypothesis:

The objective is to compare two types of wound closure after total shoulder arthroplasty to determine which closure is faster, and subsequently if there are different outcomes between the two types of closures.

The objective of this study is to compare two types of wound closure after total shoulder arthroplasty procedures. A single fellowship trained shoulder surgeon will perform all procedures. We hypothesize that patients who undergo an OCA mesh closure will have a

faster closure time, lower cost, non-inferior complication rate, and non-inferior patient satisfaction scores with respect to their postoperative follow up and scar appearance.

Patients in the OCA mesh cohort will be compared to patients who have a closure with a running monocryl suture and dermabond. This investigation seeks to determine if OCA closure mesh closure is non-inferior to monocryl suture and dermabond in terms of operative time, cost, complications, and aesthetic appearance.

If the hypothesis is confirmed, this study will suggest that a OCA mesh closure may be used for total shoulder arthroplasty surgeries as an alternative to current conventional closures and may provide a cost benefit.

Specific Goal:

1) To specifically be able to make a recommendation of total shoulder wound closure based on complications, aesthetic result, time to closure, and cost

Specific Aims:

1) To compare the timing of total shoulder closure between OCA mesh and monocryl/dermabond closure
2) To compare the costs of the OCA mesh closure versus monocryl/dermabond
3) To compare the complications the OCA mesh closure versus monocryl/dermabond closure
4) To compare the healing and patient satisfaction of wounds between the OCA mesh closure versus monocryl/dermabond closure

Study Plan:

The study will be implemented at the Wakefield Campus of Montefiore medical center by randomizing patients undergoing total shoulder arthroplasty to receiving closure with monocryl and dermabond versus dermabond with self-adhering mesh. Participants will be subsequently followed for 3 months to evaluate wound healing and monitor for complications.

Methods:

- Design – Prospective randomized intervention
- Setting - Wakefield Hospital of Montefiore Medical Center
- Participants – Patients who agree to participate in the study undergoing total shoulder arthroplasty
- Study Period
    - Sample size – 22 patients
        - Determine using a standard between-groups sample size calculation with a type 1 error rate of 5% and 80% power to detect a moderate effect size (0.5 standard deviation)
    - Inclusion
        - Total shoulder arthroplasty
        - Reverse total shoulder arthroplasty

        - Age 18-100
        - Single Surgeon
    - Exclusion
        - Previous shoulder surgery
        - Known wound healing complications
            - DM, chronic steroid use, vascular insufficiency, morbid obesity (BMI>40), ESRD, family hx of pathologic scars
        - Patients on blood thinners (ASA 81mg ok)
        - Connective tissue disease
        - Allergy to skin adhesive
        - Mentally unable to complete questionnaires
        - Previous wound over planned incision
- Measures
    - Time for closure
    - Cost of closure (time in OR, materials)
    - Wound cosmesis
        - Patient and Observer Scar Assessment Scale (POSAS)
    - Wound complications (i.e. dehiscence)
    - Wound drainage
    - Infection (superficial vs. deep)
    - Length of stay in hospital
- Endpoints
    - Primary endpoint is to determine which method of closure is faster
    - Secondary endpoints will include cost of closure, difference in wound complications, aesthetic differences, and difference in patient satisfaction
- Independent Variables
    - Age
    - BMI
    - Race
    - Gender
    - Length of Incision
    - Depth of Incision
    - Prealbumin
    - Albumin
    - Glucose
- Randomization and blinding
    - A random number generator will be used to assign patients to the study and control groups. Patients will not be notified which group they had been assigned to, though they may be able to determine which group they are in after looking at their wound.

Study Protocol:
20 total shoulder replacement patients presenting to Wakefield Medical Center will be screened for eligibility according to the inclusion and exclusion criteria by study personnel. Medical history and demographic data will be collected and assessed to ensure

that patients meet the inclusion and exclusion criteria. Eligible subjects will be enrolled after informed consent is obtained.

- Prospective Randomized Design
    - After determining a patients' eligibility for inclusion, they will be randomized to the OCA mesh group or monocryl with dermabond group. After surgery, both groups will be seen at their 2 week, 6 week, and 3 month appointment.
- Surveys
    - At the 6 week, and 3 month follow up appointment both groups and the same surgeon will complete a patient observer and scar assessment scale survey
    - The Patient Observer and Scar Assessment Scale validated instrument created to measure patients and physician overall satisfaction with surgical wound appearance / healing [17]
- Data Collection
    - For each enrolled subject, we will collect data from hospital presentation to discharge on standard demographics, routine laboratory results, clinical information, past medical history and hospital course data (length of stay, mobilization status, associated inpatient procedures and complications). Major complications are defined as: all-cause re-hospitalization, re-hospitalization relating to index surgery, DVT, PE, deep wound infection, dislocation, fracture, death. Minor complications include: UTI, delayed wound healing, superficial wound infection. Complications resulting from the surgery will be distinguished from those resulting from pre-existing conditions and comorbid states.
    - All the data will be recorded and stored in a password-protected Excel spreadsheet on study personnel password-protected work computers.
- Statistical Considerations
    - Power Analysis
        - Power Power analysis (IBM SPSS 21) was performed before the study at a level of 0.05 alpha error and 0.8 beta error. Looking at closure time of total shoulder arthroplasty wounds, looking for an effect size of 13 minutes between closure groups determined that a sample size of 2 patients in each group was adequate to detect significant differences in closure times between groups. Increasing group size to 5 patients in each group resulted in a power of 88% at an alpha of 0.05 and using 10 patients in each group resulted in 100% power at an alpha of 0.05.

Measures to address study aims:

<u>To address specific aim 1:</u> We will first measure the length of the incision and depth of the wound with a intraoperative flexible ruler prior to closure. We will assess the timing of closure in the operating room by the surgeon announcing the start of closure. At this time, the circulating nurse will start monitoring time with a stopwatch. Once the dressings are completely on, the surgeon will announce to end time and the circulating nurse will stop the stopwatch. The timing of closure will be recorded.

To address specific aim 2: We will compare the costs of the two closure methods by determining the cost of the medical supplies used for closure, as well as calculating the cost of the operating room time that was required for each closure. The sum of these costs will be the total cost of closure.

To address specific aim 3: We will compare complications, including drainage and infection, between the groups over a 3 month period.

To address specific aim 4: We will compare POSAS scores between the study group and control group at the 6-week postoperative follow up visit and 3 month postoperative follow-up visit.

Informed Consent

Informed consent procedure will take place during the preoperative consultation in the clinic setting or at any point during the hospital admission where the procedure is to be performed. This consent process will occur prior to the day of surgery. Study personnel including Dr. Brandon M. Tauberg, Dr. Konrad Gruson, or Dr. Brittany Schwartz will approach patients in a manner, time, and location that insure participant privacy. Information about the study will be conveyed to the participant in simple understandable English. The information that will be provided to prospective subjects will include the studies purpose, the risks associated with the study, the potential benefits of the study, study requirements, and a request for compliance with study procedures.

Ample time and opportunity for patients to consider all options and ask questions will be given before signing the informed consent form. All participants' questions will be answered. Verbal confirmation that the participant has comprehended the information and options provided will be obtained through Talk Back technique.

Upon agreeing to participate in the study, patients will provide written consent using an IRB-approved informed consent document. Enrolled subjects will be provided with copies of signed consent documents. Efforts will be made to continue to provide information and options as the participant or research requires.

Safety Considerations

Total joint arthroplasty closure techniques vary widely based on surgeon preference and practices. In shoulder arthroplasty, closure with monocryl suture, dermabond, nylon suture, and staples have all been used. In total joint arthroplasty, OCA mesh closure is also used. Safety risks of the OCA mesh may include wound dehiscence, drainage, infection and need for re-operation. However, these risks are minimal and should not be significantly different in the control and study groups. If there is any concern that the OCA mesh is leading to increased complications, the study will be abandoned. Additionally, if there are indications of wound complications that need alternative treatment, including revision closure, the study will be abandoned. Pregnancy testing will be done as part of the normal preoperative labs in women of child-bearing age.

Confidentiality of Research Records
Confidentiality will be protected by assigning a unique masked ID that will be linked to subjects' identifiers (e.g., name).

Storing documents in hard copy:
Any documents that contain PHI (e.g., consent forms, link between the ID to subjects' identifiers, de-identified research documents) will be stored in a locked cabinet within the office of Dr. Konrad Gruson. IRB-approved study personnel will be the only individuals with access to any research documents containing PHI.

Storing Documents Electronically
Any documents that contain PHI (e.g., consent forms, subject identifier/deidentifier table) will be stored in a password protected computer document on the primary investigator's desktop computer. Only IRB approved personnel will be the only individuals with access to any research documents containing PHI. Randomization information will be kept in a password-protected file on the computer of Dr. Konrad Gruson.

Storing Documents on Portable Electronic Devices
No PHI or research data will be stored on any portable electronic devices (e.g., laptops, tablets, flash drives, etc.)

Emailing Data
Any research data that will be emailed will be de-identified and encrypted according to Montefiore Medical Center ITS department standards. PHI will not be emailed to any commercial email addresses.

Potential Benefits
The proposed potential benefits of this study may include faster surgical times, decreased operative costs, equivalent or improved complication rates, and improved patient satisfaction. There is evidence to support OCA mesh closure is faster and has similar complications.

Follow-up procedures
The data collection period for each patient will begin during the preoperative visit and end after each patient completes the in clinic 3-month follow up visit and study surveys patient reported outcome scores will be followed indefinitely.

Early termination/discontinuation of the study protocol
Once enrolled, patients may elect to discontinue participation in the study at any time, as per the language set forth in the consent document. Note: if randomized and subjects opt out afterwards, they will be in the intention to treat category. Patients who elect to leave the study will not be followed further and their data will be managed in an appropriate fashion.

Data and Safety Monitoring

The signed assurances of the PI (Dr. Konrad Gruson) included in the CCI/IRB Research Application form, including the policy for reporting internal and external adverse events should constitute a sufficient plan. Additionally, as a single site and small numbers of study subjects, close monitoring every 3 months by the study investigators (Dr. Brandon Tauber and Dr. Brittany Schwartz) should be adequate as well. An independent data safety monitor will be appointed..

Project Management
Konrad Gruson, MD – Primary Investigator – will be responsible for the research protocol, study implementation plan, obtaining consent from eligible patients, and data analysis and interpretation

Brandon M. Tauberg, MD – Primary Resident Investigator – will be responsible for the research protocol, study implementation plan, subject screening, obtaining consent from eligible patients, data collection and analysis, and coordination between different departments and ancillary services.

Brittany Schwartz, MD – Secondary Resident Investigator - will be responsible for the research protocol, study implementation plan, subject screening, obtaining consent from eligible patients, data collection and analysis, and coordination between different departments and ancillary services.

Expected Outcomes
The expected Outcomes of this randomized prospective study is faster closure times and non-inferior complication rates with equivalent patient satisfaction for the OCA mesh group compared to the conventional closure group. There is no expected increase in adverse outcomes for the OSA mesh group.

Appendix:
See attachments

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