



## Original research

## Closing Time: One Last Call for Patient Preference

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## ABSTRACT

**Background:** Wound closure method in total hip and knee arthroplasty is a controversial topic with no differences in clinical outcomes between surgical staples (SS) and subcutaneous sutures with Dermabond (SCD). When clinically appropriate, providers should focus more on what the patient may prefer. This study aimed to collect data on patient preference between SS and SCD and analyze differences in preference based on gender and previous surgical histories.

**Methods:** Patients were surveyed on their wound closure preferences prior to surgery. The handout given collected preference and patient demographics. Risk ratios and risk difference with 95% confidence intervals (95% CI) were calculated along with Firth-corrected logistic regressions.

**Results:** A total of 163 participants were analyzed (53% female) (average age = 63.8 years), in which 12 participants selected SS as their preferred method. Males demonstrated no difference in relative risk (risk ratio: 2.3 [95% CI: 0.7, 7.3],  $P = .150$ ) or absolute risk (risk difference: 5.9 [−2.2, 14.1],  $P = .156$ ) in choosing SS over SCD. Patients that previously sustained SS for other surgeries demonstrated no difference in adjusted odds (adjusted: 0.9 [95% CI: 0.2, 3.2],  $P = .839$ ) in choosing SS over SCD.

**Conclusion:** More patients favored SCD over SS. There was no difference in preferences based on gender or previous surgical history. Current literature shows that successful wound closure is achieved with minimized risks for infection and other complications using both methods. Providers should adopt a patient-centric approach and perform the closure method that most patients prefer when medically warranted.

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## Introduction

With an aging population in the United States and globally, the demand for total hip (THA) and knee arthroplasties (TKA) is projected to grow by 174% (THA) and 673% (TKA) by 2030, as common surgical interventions to treat end-stage degenerative arthritis [1,2]. In the United States, TKAs performed each year are estimated to be 3.48 million procedures by 2030 [1]. Although joint replacements are a boney procedure, great attention is also placed on balancing the soft tissues and meticulous soft tissue closures [3]. The goals of total joint replacement are to reduce pain, regain mobility, minimize infection rates, and enhance recovery times, all while driving efforts toward successful high-tension wound healing

[4]. Draining wounds after total joint procedures constitutes a significant source of contamination and high risk for deep infection, which drastically affects long-term outcomes and patient satisfaction [5]. As a result, there has been ongoing research to assess the efficacy of the various wound closure methods and evaluate the rates of complications and quality-associated expectations of different closure techniques following THA and TKA [6].

There are two primary skin-level wound-closing techniques used in THA and TKA, namely surgical staples (SS) and subcuticular sutures with Dermabond (Ethicon, Cincinnati, OH) (SCD) [7]. As demonstrated in a large meta-analysis of existing randomized controlled trials, the current literature shows insignificant differences between these two methods of wound closures [7]. The cosmetic appearance is also insignificant between the two most popular options [8]. Glennie et al. demonstrated that their patient groups, either receiving SS or SCD, had no differences in the Patient and Observer Scar Assessment Scale [9].

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On average, a wound site following total joint arthroplasty is about 14 cm. At our institution, the cost breakdown is as follows, 1 stapler (\$46.20), 1 3.0 Monocryl antibacterial version 8-count CRP (Ethicon) (\$8.89), 1 Dermabond (\$54.83), Staple Removal kit (Ethicon) (\$0.63). Previous research has observed a significant difference in the suturing time for physicians, with SS averaging 81 seconds for wound closure compared with 290 seconds for SCD [10]; however, there was no significant discrepancy in the wound drainage time [10]. Another study examining TKA closure times from the joint capsule to the cutaneous layer demonstrated that SS took 26 seconds/cm, Dermabond took 45 seconds/cm, and Monocryl Sutures took 54 seconds/cm [11]. As these numbers are different from those in the study conducted by Hlubek et al., the current literature is inconclusive as to the superior method in time of application [10].

THA/TKA are intensive procedures, and it is crucial to have a patient-centered approach to ensure each patient is comfortable and understands the risks involved. Previous research demonstrates that patients undergoing major surgeries, such as total joint replacements, often conduct extensive research on choosing a surgeon that fits their individual needs [12]. *Patient surgeon choice* is a business-oriented decision contingent upon patient satisfaction [12]. Additionally, the concept of shared decision-making (SDM) in surgery highlights improved patient outcomes in alleviating internal stress, improving compliance routines, and decreasing the burden of costs for preventable complications [13]. Therefore, it is vital for surgeons to better understand patients' preferences concerning wound closing as it is one of the few things the patient can see, and so it gives them a powerful feeling of control over their bodies and promotes patient-surgeon SDM.

On all major factors, the use of SS vs SCD for wound closure after THA/TKA is insignificant, and therefore, when clinically appropriate, providers should focus more on patient preference. Since preferences vary based on patient demographics, it is important to understand the prevalence of preferences based on the factors of gender and previous surgical history. We hypothesize that most patients undergoing elective THA/TKA operations would prefer a SCD closure for the incision site. Therefore, the aims of this study were to (1) determine and describe patient preference in wound closure methods following hip and knee replacement surgery; (2) evaluate the relationship between gender and previous surgical history on patient preference in wound closure methods.

## Material and methods

### *Collecting patient perspectives*

A cross-sectional study design was utilized to assess wound closure preference in patients undergoing THA or TKA. Patients were given a patient handout survey assessing preference in wound closure technique following total joint replacement surgery (Fig. 1). The patient was questioned by the researcher on whether they preferred wound closure using SS or SCD. It was made clear to the patient that the response to the survey had no impact on the actual closure method utilized during their surgery. The survey was phrased based on a hypothetical situation, asking if patients could select a wound closure method for their operation, to know which method is more desirable from patients' perspective. Each patient was briefly informed of the two options, always in the order of SS then SCD, including the removal process and the expectations for wound evaluation after 2 weeks. Description of SS highlighted the superficial clips made of titanium, plastic, or stainless steel, involving a removal process at 2 weeks postoperatively. Description of SCD included a closure in the second layer of skin using absorbable sutures, with no removal process, along with a

supplemental application of a skin adhesive (Dermabond). The hospital institutional review board approved this study.

### *Participant recruitment*

Patient surveys were performed at an outpatient orthopedic clinic between May 2021 and July 2021. Inclusion criteria included any patient scheduled for a total joint arthroplasty surgery, including those patients consenting for revision surgery or partial joint replacement surgery. In those patients eligible for and undergoing future THA or TKA, there were no study exclusion criteria based on existing medical conditions, previous surgical history, or other factors. Sample size determination was based on recent cross-sectional studies assessing patient opinions and preferences in which an average sample size of 100–200 was recorded in most studies. A pre-hoc power analysis was not performed.

### *Patient details collected*

In addition to assessing patient preference by a check-off section on the handout, the study also collected brief patient demographics such as the patient's age and sex. The handout also recorded the current procedure the patient was scheduled for, either being a hip or knee arthroplasty, along with the side of the body (left/right or bilateral). Lastly, the form also recorded patients' past surgical histories along with the method used to close the wound of their previous operation (Fig. 1).

### *Standard wound closure materials*

The standard choice of SS was applied using the device Visistat 35W stapler (Teleflex Corp, Morrisville, NC), an Food and Drug Administration (FDA)-approved Weck staple system with stainless steel staples [11]. Monocryl sutures (poliglecaprone 25; Ethicon) are FDA-approved dissolving monofilament sutures for soft tissue ligations with varying tensile strengths from 30% to 40% at the 2-week mark [14]. The monocryl suture (poliglecaprone 25; Ethicon) is hydrolyzed and absorbed into the body within 91 to 119 days with no formal removal process [14]. Dermabond (2-octyl-cyanoacrylate; Ethicon) is an FDA-approved high-viscosity skin adhesive used for wound closures over the past 30 years and is proven to be an effective method for bonding the superficial layers of cutaneous tissues [15].

### *Data recorded*

All data collected were deidentified and uploaded into REDCap (Research Electronic Data Capture) electronic data capture tools hosted at the Wake Forest School of Medicine [16]. The software enables our researchers to deidentify and protect the patients participating in this study [17].

### *Statistical analyses*

Prior to analysis, missing data were assessed. Missing data were 0% for all variables; thus, complete case analyses were performed. Descriptive statistics were reported as mean (standard deviation) for continuous variables and percent for count variables. Relative and absolute risk were assessed for sex and previous surgical wound closure history through risk ratios (RRs) and risk difference (RD) with 95% confidence intervals (95% CI). RR provides a relative risk calculation, which is the ratio of risk between the exposure group (ie, males or staples for previous surgical wound closure) and the nonexposure group (ie, females or sutures with Dermabond for previous surgical wound closure). RD, or attributable risk, provides

an absolute risk calculation, which is the difference between the exposure group (ie, males or staples for previous surgical wound closure) and the unexposed group (ie, females or sutures with Dermabond for previous surgical wound closure). A series of Firth-corrected logistic corrections were performed to assess the relationship between sex and surgical wound closure choice and previous surgical wound closure history and current surgical wound closure choice. Firth-corrected logistic regressions were controlled for previous surgical history and current surgical procedure (THA vs TKA) for the sex analysis and controlled for sex and current surgical procedure (THA vs TKA) for the previous surgical wound closure history analysis. All analyses were performed in R version 4.02 (R Core Team [2013]; R: a language and environment for statistical computing, using the *dplyr* package for cleaning and coding, *epiR* package for risk calculations, and *logistf* for Firth corrected logistic regressions).

**Results**

A total of 163 patients participated, with 12 (7%) choosing staples for wound closure preference (Table 1). Males demonstrated no difference in relative risk (RR: 2.3 [95% CI: 0.7, 7.3], *P* = .150) or absolute risk (RD: 5.9 [−2.2, 14.1], *P* = .156) in choosing staples over sutures with Dermabond for surgical wound closure. Patients that previously sustained staples for surgical wound closure demonstrated no difference in relative risk (RR: 0.70 [95% CI: 0.19, 2.6], *P* = .584) or absolute risk (RD: −2.8 [95% CI: −12.1, 6.7], *P* = .567) in choosing staples over sutures with Dermabond for surgical wound closure.

*Odds of surgical wound closure choice*

Males demonstrated no difference in unadjusted or adjusted odds (unadjusted: 2.3 [95% CI: 0.7, 8.3], *P* = .157; adjusted: 2.3 [95%

# WHAT METHOD DO YOU PREFER?



## POST SURGERY WOUND-CLOSURES

### Purpose of Survey

YOUR ANSWERS **WILL NOT AFFECT** HOW YOUR SURGERY IS CLOSED.

- OUR GOAL IS TO DETERMINE WHAT METHOD OF WOUND CLOSURE PATIENTS PREFER
- THE TWO OPTIONS INCLUDE:
  - 1) SURGICAL STAPLES
  - 2) A BELOW THE SKIN CLOSURE WITH DERMABOND

THE SURVEY IS SIMPLY FOR INFORMATIONAL PURPOSES TO HELP PROVIDERS BETTER UNDERSTAND PATIENT PERSPECTIVES

### Below skin Sutures with Dermabond

- Subcuticular (layer under the skin) closure using sutures
- Absorbable
- No removal process



### Patient Info:

Age:  
 Sex:  
 Procedure:  
 Left/Right side of body:  
 Previous Surgery history?  
 How was it closed?

### Surgical Staples

- Specialized surgery staples, usually made from Titanium, plastics, stainless steel
- Staples applied directly onto outer layer of skin
- Requires removal by physician

Check off your preference:



**Surgical Staples**



**Below Skin Sutures with Dermabond**

Figure 1. Patient handout.

**Table 1**  
Descriptive statistics.

| Variable                                | All participants<br>(n = 163) | Participants who<br>chose staples (n = 12) | Participants who<br>chose sutures with<br>Dermabond (n = 151) |
|-----------------------------------------|-------------------------------|--------------------------------------------|---------------------------------------------------------------|
| Age                                     | 63.8 (11.2)                   | 63.7 (11.4)                                | 64.5 (8.5)                                                    |
| Sex (% female)                          | 53%                           | 33%                                        | 55%                                                           |
| Procedure                               |                               |                                            |                                                               |
| THA                                     | 39%                           | 25%                                        | 40%                                                           |
| TKA                                     | 53%                           | 58%                                        | 52%                                                           |
| Revision THA                            | 4%                            | 0%                                         | 4%                                                            |
| Revision TKA                            | 4%                            | 17%                                        | 3%                                                            |
| Side of body (% left)                   | 48%                           | 42%                                        | 48%                                                           |
| Previous surgery history                | 84%                           | 83%                                        | 84%                                                           |
| Previous closure preference (% staples) | 5%                            | 25%                                        | 3%                                                            |

All descriptive statistics are reported as mean (standard deviation) or percentage.

CI: 0.7, 8.2],  $P = .161$ ) in choosing staples over sutures with Dermabond for surgical wound closure. Patients that previously sustained staples for surgical wound closure demonstrated no difference in unadjusted or adjusted odds (unadjusted: 0.8 [95% CI: 0.2, 2.7],  $P = .672$ ; adjusted: 0.9 [95% CI: 0.2, 3.2],  $P = .839$ ) in choosing staples over sutures with Dermabond for surgical wound closure (Table 2).

## Discussion

The main finding of this study was that 93% of patients preferred to have a closure with SCD over SS. There was no difference in preference for SCD based on previous surgical history or gender. The shared preferences between varying factors are a favorable outcome noted in our study and highlight that surgeons should give attention to patient preference and perform the SCD closure method that most patients prefer when clinically applicable.

While SCD was shown to be the preferred closure method, it is imperative to acknowledge the possible risks associated with Dermabond. Studies assessing postoperative wound closure complications after THA/TKA procedures have documented a rare yet severe allergic contact dermatitis (ACD) response to Dermabond (2-octyl cyanoacrylate). A recent study conducted by Chalmers et al. demonstrated an ACD incidence of 0.5%, with ACD occurrence on average at day 11.8 after operation. The patients were treated with oral antihistamines and topical corticosteroids, in which all cases resolved on average at postoperative day 22 [18]. While these allergic reactions are severe in nature, if the warning signs are recognized early, the treatment with oral and topical medications is very effective. Overall, ACD is an uncommon adverse effect with proven treatment interventions, which significantly diminish risks for the patient.

The findings imply that when a surgeon deems SS and SCD as both plausible methods based on the patient's clinical conditions,

**Table 2**  
Firth-corrected logistic regression results for sex and previous surgical wound closure.

| Variable                             | Odds ratio | 95% Confidence interval | P value |
|--------------------------------------|------------|-------------------------|---------|
| Sex                                  |            |                         |         |
| Male <sup>a</sup>                    | 2.3        | 0.7, 8.2                | .161    |
| Previous surgical history            | 0.8        | 0.2, 4.6                | .826    |
| Total knee arthroplasty <sup>b</sup> | 1.3        | 0.4, 4.2                | .702    |
| Previous surgical wound closure      |            |                         |         |
| Previous staple closure              | 0.9        | 0.2, 3.2                | .839    |
| Male <sup>a</sup>                    | 1.7        | 0.5, 6.5                | .409    |
| Total knee arthroplasty <sup>b</sup> | 1.2        | 0.3, 4.5                | .781    |

<sup>a</sup> Reference is female.

<sup>b</sup> Reference is THA.

SCD should be the method of closure used. Of the total selections for an SCD closure, 55% of responses were from females, indicating a homogenous preference for SCD shared by males and females. In the study, the average age of patients was 63.8 years, and this represented a generalizable population for patients undergoing THA and TKA operations. SDM and electing to use the preferred method of SCD and the lack of a suture-removal process may alleviate some concerns for surgery.

## Future research

While our study focuses on the quantitative aspect of wound closure choice, a follow-up study should thoroughly analyze qualitative reasons to understand patient perspectives. It is critical to acknowledge the basis for patient preferences, such as the minority group favoring SS. Future studies should elaborate on how the removal process of SS impacts preference. Additionally, it was noticed that women with a previous surgical history of a Cesarean section often underwent a SS closure. It would be beneficial to understand the relationship between females that had previously undergone C-sections and an SS closure and determine if these patients have a bias against SS for future surgical closures.

## Limitations

The study has several limitations. Patients could not physically see how each wound closure method appears on the skin. Pictures were not given to patients as this could add biases depending on the quality of the images shown. Additionally, patients who had already undergone a THA or TKA with the current clinic physicians were included in the study. These patients received prior closures of SCD. Therefore, it is likely that these patients were influenced to select the same method based on their previous experience. While the sample size of participants was based on similar studies, sample size determination would have been more accurate if an initial pre-hoc power analysis was completed. Lastly, a significant drawback with the study is the comparably small number of participants in the SS outcome group, which potentially adds the risk of a type II error. However, a Firth-corrected logistic regression was performed to aid in minimal outcome analyses.

## Conclusions

Based on our findings, most patients prefer a wound closure with SCD over SS, with variables of patient gender, age, and past surgical history as nonfactors. Among the patients undergoing THA compared with those undergoing TKA, there were also no differences in preference for closure with SCD. Given the complexity of

individual surgical cases, surgeons cannot always use sutures or staples, but in situations where it is plausible to choose, the doctor should consider using SCD as that is the preferred method of closure for most patients. Therefore, our study encourages providers to engage in SDM with patients and, when applicable, use the method of wound closure that is in line with most patients undergoing THA or TKA procedures.

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### Conflicts of interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: J. S. Shields is a paid consultant for Smith & Nephew.

For full disclosure statements refer to <https://doi.org/10.1016/j.artd.2022.02.022>.

### References

- [1] Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *J Bone Joint Surg Am* 2007;89(4):780.
- [2] Choi YJ, Ra HJ. Patient satisfaction after total knee arthroplasty. *Knee Surg Relat Res* 2016;28(1):1.
- [3] Galat DD, McGovern SC, Hanssen AD, Larson DR, Harrington JR, Clarke HD. Early return to surgery for evacuation of a postoperative hematoma after primary total knee arthroplasty. *J Bone Joint Surg Am* 2008;90(11):2331.
- [4] Miller AG, Swank ML. Dermabond efficacy in total joint arthroplasty wounds. *Am J Orthop (Belle Mead NJ)* 2010;39(10):476.
- [5] Hungerford DS, Krackow KA. Total joint arthroplasty of the knee. *Clin Orthop Relat Res* 1985;(192):23.
- [6] Kim KY, Anoushiravani AA, Long WJ, et al. A meta-analysis and systematic review evaluating skin closure after total knee arthroplasty—What is the best method? *J Arthroplasty* 2017;32(9):2920.
- [7] Krishnan RJ, Crawford EJ, Syed I, Kim P, Rampersaud YR, Martin J. Is the risk of infection lower with sutures than with staples for skin closure after orthopaedic surgery? A meta-analysis of randomized trials. *Clin Orthop Relat Res* 2019;477(5):922.
- [8] Wang LS, Wang XY, Tu HT, Huang YF, Qi X, Gao YH. Octyl-2-cyanoacrylate tissue adhesive without subcuticular suture for wound closure after total hip arthroplasty: a prospective observational study on thirty-two cases with controls for 3 months follow-up. *J Orthop Surg Res* 2020;15(1):1.
- [9] Glennie RA, Korczak A, Naudie DD, Bryant DM, Howard JL. MONOCRYL and DERMABOND vs staples in total hip arthroplasty performed through a lateral skin incision: a randomized controlled trial using a patient-centered assessment tool. *J Arthroplasty* 2017;32(8):2431.
- [10] Hlubek R, Walder P, Káňa J, Salounová D. Použití kovových klipů při sutuře kůže u totální endoprotézy kolene [Metal staples versus conventional suture for wound closure in total knee arthroplasty]. *Acta Chir Orthop Traumatol Cech* 2014;81(3):233.
- [11] Eggers MD, Fang L, Lionberger DR. A comparison of wound closure techniques for total knee arthroplasty. *J Arthroplasty* 2011;26(8):1251.
- [12] Harris KM. How do patients choose physicians? Evidence from a national survey of enrollees in employment-related health plans. *Health Serv Res* 2003;38(2):711.
- [13] De Mik SML, Stubenrouch FE, Balm R, Ubbink DT. Systematic review of shared decision-making in surgery. *J Br Surg* 2018;105(13):1721.
- [14] Chu CC. Materials for absorbable and nonabsorbable surgical sutures. In: *Biotextiles as medical implants*. Woodhead Publishing; 2013. p. 275.
- [15] Shapiro AJ, Dinsmore RC, North Jr JH. Tensile strength of wound closure with cyanoacrylate glue. *Am Surg* 2001;67(11):1113.
- [16] Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap) – a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42(2):377.
- [17] Harris PA, Taylor R, Minor BL, et al., REDCap Consortium. The REDCap consortium: Building an international community of software partners. *J Biomed Inform* 2019. <https://doi.org/10.1016/j.jbi.2019.103208>.
- [18] Chalmers BP, Melugin HP, Sculco PK, et al. Characterizing the diagnosis and treatment of allergic contact dermatitis to 2-octyl cyanoacrylate used for skin closure in elective orthopedic surgery. *J Arthroplasty* 2017;32(12):3742.