**Name of Journal:** *World Journal of Methodology*

**Manuscript NO:** 55178

**Manuscript Type:** ORIGINAL ARTICLE

***Randomized Clinical Trial***

**Randomized clinical trial comparing skin closure with tissue adhesives *vs* subcuticular suture after robotic urogynecologic procedures**

Fluellen S *et al.* Laparoscopic port closure

Sunetris Fluellen, Kyle Mackey, Karen Hagglund, Muhammad Faisal Aslam

**Sunetris Fluellen, Kyle Mackey, Muhammad Faisal Aslam,** Department of Obstetrics and Gynecology, Ascension St John Hospital and Medical Center, Detroit, MI 48236, United States

**Karen Hagglund,** Medical Research, Ascension St John Hospital and Medical Center, Detroit, MI 48236, United States

**Author contributions:** Fluellen S designed and performed the research study; Mackey K wrote manuscript; Hagglund K performed data analysis; Aslam MF designed research study.

**Corresponding author: Kyle Mackey, MD, Doctor,** Department of Obstetrics and Gynecology, Ascension St John Hospital and Medical Center, 22101 Moross Road, Detroit, MI 48236, United States. kyle.mackey@ascension.org

**Received:** March 9, 2020

**Revised:** October 6, 2020

**Accepted:** October 13, 2020

**Published online:**

**Abstract**

BACKGROUND

Skin closure techniques during minimally-invasive gynecologic surgery is largely based on surgeon preference. The optimum technique would theoretically be safe, rapid, inexpensive, and result in good cosmetic appearance. Cyanoacrylate tissue adhesive (Dermabond*)* may be a comparable and safe option for port site closure as compared with subcuticular suture. In this randomized clinical trial, we hypothesized that operative time for skin closure would be less than subcuticular suture during robotic urogynecologic procedures.

AIM

To compare skin closure during robotic urogynecologic surgeries for tissue adhesives and subcuticular suture.

METHODS

Fifty female subjects > 18 years of age undergoing robotic urogynecologic procedures were randomized to have port site closure with either cyanoacrylate tissue adhesive (*n* = 25) or subcuticular suture (*n* = 25). All procedures and postoperative evaluations were performed by the same board certified Female Pelvic Medicine and Reconstructive Surgeon. Incisional closure time was recorded. Each subject was followed for 12-wk postoperatively. Incision cosmesis was evaluated using the Stony Brook Scar Evaluation Scale.

RESULTS

A total of 47 subjects (cyanoacrylate group, *n* = 23; suture group, *n* = 24) completed the 12-wk postoperative evaluation. Closure time was significantly less (*P* < 0.0005) using cyanoacrylate tissue adhesive (5.4 ± 2.0 min) than subcuticular suture (24.9 ± 5.6 min). Cosmesis scores were significantly higher in the cyanoacrylate tissue adhesive group than subcuticular suture (*P* = 0.025). No differences were found between bleeding, infection, or dehiscence (*P* = 1.00, *P* = 0.609, *P* = 0.234, respectively). No statistical demographical differences existed between the two study arms.

CONCLUSION

Our study supported our original hypothesis that cyanoacrylate tissue adhesive for port site closure during robotic urogynecolgic procedures uses less time than with subcuticular suture. Our study also supports that tissue adhesive is comparable to cosmetic outcome while not jeopardizing rates of bleeding, infection, or dehiscence.

**Key Words:** Skin closure in robotic surgery; Dermabond; Cosmesis; Urogynecology; Closure time

Fluellen S, Mackey K, Hagglund K, Aslam MF. Randomized clinical trial comparing skin closure with tissue adhesives *vs* subcuticular suture after robotic urogynecologic procedures. *World J Methodol* 2020; In press

**Core Tip:** This clinical trial study is novel in its investigation of traditional *vs* innovative skin closure techniques with respect to closure time, cosmesis, and equivalency during urogynecologic robotic procedures. Our study demonstrated a reduction in closure time, improved cosmetic healing while not jeopardizing incidence of wound complications. This supports the use of tissue adhesive as being not only comparable, but also advantageous during closure of robotic urogynecologic procedures.

**INTRODUCTION**

For many years, we have used suture, staples and adhesive tapes as methods of skin incision closure. The choice of which method to use is largely based on the surgeon’s preference. Of the three methods, tissue adhesives have entered the clinical practice most recently. Although repairing surgical wounds with suture is the most common method, it is operator dependent, carries an increased risk of needle sticks to the practitioner, and requires more operating room time[1,2]. The ideal method of incision closure should be simple, safe, rapid, inexpensive, painless, bactericidal, and result in optimal cosmetic appearance of the scar[1]. The use of tissue adhesives offers multiple advantages such as: barrier protection to aid in wound healing, shorter operating room time, elimination of the risk of sharps exposure *via* needle sticks, and comparable cosmesis to standard closure methods[3].

Dermabond glue, a cyanoacrylate tissue adhesive, is a liquid monomer that forms a strong tissue bond with a protective barrier that adds strength and inhibits bacteria[4]. It is applied as a bridge over the opposing skin edges and forms a flexible seal over the wound[5]. The adhesive reaches maximum bonding strength within 2.5 min and is equivalent in strength to healed tissues at seven days post repair[5]. Skin closure with tissue adhesive is more rapid than standard suture, and both wound dehiscence and infection rates are similar[1]. Most importantly, the cosmetic appearance with tissue adhesives is similar to incisions closed with standard suture methods[1].

The ideal scar assessment tool should be a validated, comprehensive, reliable and standardized tool[3,6]. Recommendations in recent reviews of scar management strategies support a move to a more evidence-based approach in scar assessment and management[7]. The Stony Brook Scar Evaluation Scale is specifically designed to assess short-term appearance of repaired lacerations or incisions[8]. Of course, patients are concerned about the physical appearance of scars as poorly healed scars can have major psychological effects; therefore, when deciding on closure method one needs to take into account postoperative aesthetics.

The primary outcome of the study was to compare skin closure time between suture and cyanoacrylate tissue adhesive (Dermabond) in urogynecological robotic surgeries. Therefore, if the tissue adhesive was cosmetically comparable to that of sutures that will be the reason to use tissue adhesives over traditional sutures due to saved operative time. In these surgeries, there are five to six port sites (compared to fewer port sites for traditional laparoscopic procedures), and the procedures are lengthy (average duration about 300 min as per American Society of Gynecologic Urology/American College of Obstetricians and Gynecologists committee opinion). If we can show significant time reduction for closure, that should reduce operative time and costs. To our knowledge, this is the first study of its kind to make this comparison for urogynecologic robotic procedures.

**MATERIALS AND METHODS**

This randomized controlled trial compared skin closure after robotic urogynecologic surgery with tissue adhesive *vs* subcuticular suture. This study is registered at clinicaltrials.gov (ID: NCT03891004). Between March 2018 and December 2018, we randomized 50 women, 25 in each group. The primary outcome, closure time, was measured in the operating room. Incision cosmesis, the secondary outcome, between the two arms was measured at the 12-wk follow up visit using the Stony Brook Scar Evaluation Scale (Table 1). For randomization, a computer randomization program was used to assign group assignments to the numbers 1 to 50. Security envelopes were numbered from 1 to 50, and a piece of paper with the group assignment was placed in a sealed, opaque envelope with the corresponding number. The study number became the patient’s study ID, and the assignment within the numbered envelope became patient’s group assignment.

Our estimates, based on surgical experience and our pilot data, were that the standard (stitch) approach would take a mean of 16.0 min (standard deviation 3.0 min), compared to the tissue adhesive only, which will take a mean of 13.0 min (standard deviation 3.0 min). To show such an effect, at least 17 patients were required per group, for 80% power and alpha = 0.05. To allow for attrition, we added 20% to the sample size and recruited 25 patients per group. Closure time was compared by group using the Student’s *t*-test, and cosmesis scores were compared by group using the Mann-Whitney *U*-test. The median and interquartile range was reported for each group. *P* < 0.05 were considered significant. Associations between categorical variables were made with chi squared or Fisher exact test as appropriate, and again the Mann-Whitney *U* test was used for continuous variables.

Study subjects were women, ages 18 years and older, undergoing urogynecologic robotic procedures that were ultimately not converted to open cases. Women with active skin infections were excluded from the study, along with any of the procedures that were converted to a laparotomy (although none of the procedures in our study were converted to laparotomy). These procedures involved five to six port incisions which required closure at the end of the case. Women were invited to participate in the study during their preoperative visit. An explanation of the study was given, and informed consent obtained. Randomization to one of the two groups occurred at the end of the surgery so that the surgeon was aware of which closure method to use. A fellowship trained, board certified, FPMRS surgeon was the primary surgeon for every procedure.

For the tissue adhesive group, Dermabond was used. Dermabond was food and drug administration approved for skin closure in 1998. For the suture arm, only the subcuticular layer was closed. We recorded the length of time of each closure method for comparison, and had each patient follow-up at two, six and 12 wk. At the 12-wk visit the appearance of the incision was scored using the Stony Brook Scar Evaluation Scale.

Each method of closure was safe and effective; therefore, the fastest method is more ideal to cut down on operating room time and cost. The secondary outcomes that we focused on were comparing cosmesis of the incisions and patient satisfaction regarding cosmesis at the 12-wk postoperative visit. One certified registered nurse evaluated all of the patients at the 12-wk postoperative visit, and was blinded to each patient’s group assignment.

**RESULTS**

The study enrolled 50 patients, 25 patients in each arm, however a total of 47 patients completed their 12-wk postoperative visit (*n* = 23 in tissue adhesives group, *n* = 24 in the suture group). The primary outcome, length of time for each closure method, was significantly less (*P* < 0.0005) in the tissue adhesive group (5.415 ± 2.035 min) when compared to the suture group (24.98 ± 5.665 min). It was determined that the cosmesis score was significantly higher (*P* = 0.025) in the tissue adhesives group (median = 4.0, interquartile range = 1.0) than in the suture group (median = 3.0, interquartile range = 2.0). There was no significant difference in bleeding (*P* = 1.00), dehiscence (*P* = 0.234), infection (*P* = 0.609) or any extra wound treatment (*P* = 1.00) between the two arms.

When comparing patient demographics between the two study arms, there was no statistical differences (Table 2).

**DISCUSSION**

The major findings of our study showed that the length of closure time was significantly shorter in the tissue adhesive group (5.4 ± 2.0 min) than that of the suture group (24.9 ± 5.6 min). Furthermore, tissue adhesives result in a superior cosmetic appearance of the scar without increasing the risk of wound complications in robotic urogynecologic surgery. When comparing complications such as wound dehiscence, infection, bleeding and other complications requiring extra wound treatment, there was no significant difference between the two arms. In our study, none of the patient’s assigned to the Dermabond arm experienced an allergic reaction or contact dermatitis. It is said that there is a female predominance of acrylate allergy, with a male/female ratio of 1:15[9]. If an adverse reaction is noted, studies have shown to observe the wound until the product peels off spontaneously[10].Occasional use of systemic steroids is sometimes required for a severe allergic reaction[10].

The Stony Brook Scar Assessment, as shown in Table 2, was the ideal scar assessment tool as it is specifically designed to assess short-term appearance of repaired lacerations or incisions[8].This tool assigns a score to 5 aesthetic parameters and yields a total score ranging from 0 (worst) to 5 (best). Although caution should be used with the clinical application of scar assessment tools as they are subjective and hard to standardize, cosmesis and patient’s satisfaction were the main goals of the study.

Understanding operative times and hospital costs is essential to value-based care. There is a growing body of literature describing cost-saving interventions in surgery[11-14].As a reference point, a cross-sectional analysis performed in California showed the mean cost of operating room time in the fiscal year of 2014 was $36 to $37 per minute[15].Therefore, it was our main goal to show that tissue adhesives can substantially decrease operative times which furthermore decreases cost. Additionally, a study by Sebesta and Bishoff (2003) showed a reduced cost and procedural time for cyanoacrylate tissue adhesive for laparoscopic port closures compared to subcuticular sutures[16].

The study did have its limitations. One limitation was cost. We did not evaluate the cost difference between the two methods. However, a study comparing laparoscopic port-site closure with octylcyanoacrylate (Dermabond) tissue adhesive to be significantly less in duration, comparable in cosmetic outcome, and significantly reduced cost ($198 United States for tissue adhesive *vs* $497 United States for suture) than with suture[16]. Another limitation is that we did not screen nor exclude patient’s with history of pathological wound healing. Anecdotally, we did not find much difference. Of note, our closure time with tissue adhesive *vs* suture was significantly reduced (less than 50%). As compared to the pilot data discussed in the methods section, this does perhaps raise the possibility of unmindful bias. However, the closure time for tissue adhesive was still markedly reduced (5.415 ± 2.035 min) compared to pilot data for suture closure (16 ± 3 min).

Our study had several strengths. The first is that this study was a randomized trial and the incision assessor was blinded to the result. Next, the study was performed at a single institution; therefore, we were able to assure uniformity of care. Both the surgeon and the scar assessor were consistent throughout the study. This subsequently decreases the potential bias in wound assessment. Fourthly, the prospective approach coupled with the high follow-up rate of the patients made this study successful. Next, another strength is we had the surgeon closing the skin with both methods, which takes bias out for the time. Lastly, to the best of our knowledge, this is the first study to use the Stony Brook Scar Evaluation Scale to evaluate skin closure cosmesis in urogynecologic robotic procedures.

**CONCLUSION**

In summary, we aimed to assess incisional cosmesis and operative time between suture and skin adhesives. Given that there was no significant difference between wound complications, tissue adhesives have proven to be the superior closure method and results in shorter operative times and can be safely adopted.

**ARTICLE HIGHLIGHTS**

***Research background***

Skin closure method during robotic urogynecologic procedures can vary overall operative time and costs. Cyanoacrylate tissue adhesive is a potential method to reduce this as compared to subcuticular suture, and maintain incisional cosmesis while not jeopardizing wound complications.

***Research motivation***

A faster yet comparable method for skin closure during robotic urogynecologic procedures may significantly reduce operative time and costs while maintaining or even improving incisional cosmesis.

***Research objectives***

To compare skin closure *via* cyanoacrylate tissue adhesive and subcuticular suture during robotic urogynecologic procedures.

***Research methods***

Fifty subjects were randomized to have port site closure with either cyanoacrylate tissue adhesive or subcuticular suture. Subjects were follow for 12-wk posteroperatively to evaluate incisional cosmesis and complications.

***Research results***

Closure time was significantly reduced using cyanoacrylate tissue adhesive than with subcuticular suture. Cosmesis scores were greater in the cyanoacrylate tissue adhesive group. No differences in bleeding, infection, or dehiscence existed.

***Research conclusions***

Cyanoacrylate tissue adhesive for skin closure during robotic urogynecologic procedures reduces operative time and improves incisional cosmesis compared to subcuticular suture. Cyanoacrylate tissue adhesive is a reasonable alternative for skin closure during robotic urogynecologic procedures.

***Research perspectives***

The utility of tissue adhesive as reducing operative time and overall costs is a potential area of future investigation.

**REFERENCES**

1 **Singer AJ**, Quinn JV, Clark RE, Hollander JE; TraumaSeal Study Group. Closure of lacerations and incisions with octylcyanoacrylate: a multicenter randomized controlled trial. *Surgery* 2002; **131**: 270-276 [PMID: 11894031 DOI: 10.1067/msy.2002.121377]

2 **Dumville JC**, Coulthard P, Worthington HV, Riley P, Patel N, Darcey J, Esposito M, van der Elst M, van Waes OJ. Tissue adhesives for closure of surgical incisions. *Cochrane Database Syst Rev* 2014; CD004287 [PMID: 25431843 DOI: 10.1002/14651858.CD004287.pub4]

3 **Draaijers LJ**, Tempelman FR, Botman YA, Tuinebreijer WE, Middelkoop E, Kreis RW, van Zuijlen PP. The patient and observer scar assessment scale: a reliable and feasible tool for scar evaluation. *Plast Reconstr Surg* 2004; **113**: 1960-5; discussion 1966-7 [PMID: 15253184 DOI: 10.1097/01.prs.0000122207.28773.56]

4 **Daykan Y**, Sharon-Weiner M, Pasternak Y, Tzadikevitch-Geffen K, Markovitch O, Sukenik-Halevy R, Biron-Shental T. Skin closure at cesarean delivery, glue *vs* subcuticular sutures: a randomized controlled trial. *Am J Obstet Gynecol* 2017; **216**: 406.e1-406.e5 [PMID: 28153666 DOI: 10.1016/j.ajog.2017.01.009]

5 **Bhende S**, Rothenburger S, Spangler DJ, Dito M. In vitro assessment of microbial barrier properties of Dermabond topical skin adhesive. *Surg Infect (Larchmt)* 2002; **3**: 251-257 [PMID: 12542926 DOI: 10.1089/109629602761624216]

6 **van de Kar AL**, Corion LU, Smeulders MJ, Draaijers LJ, van der Horst CM, van Zuijlen PP. Reliable and feasible evaluation of linear scars by the Patient and Observer Scar Assessment Scale. *Plast Reconstr Surg* 2005; **116**: 514-522 [PMID: 16079683 DOI: 10.1097/01.prs.0000172982.43599.d6]

7 **Truong PT**, Lee JC, Soer B, Gaul CA, Olivotto IA. Reliability and validity testing of the Patient and Observer Scar Assessment Scale in evaluating linear scars after breast cancer surgery. *Plast Reconstr Surg* 2007; **119**: 487-494 [PMID: 17230080 DOI: 10.1097/01.prs.0000252949.77525.bc]

8 **Fearmonti R**, Bond J, Erdmann D, Levinson H. A review of scar scales and scar measuring devices. *Eplasty* 2010; **10**: e43 [PMID: 20596233]

9 **McDonald BS**, Buckley DA. Severe dermatitis from Dermabond ® surgical glue. *Br J Dermatol* 2014; **170**: 739-741 [PMID: 24125099 DOI: 10.1111/bjd.12684]

10 **Muttardi K**, White IR, Banerjee P. The burden of allergic contact dermatitis caused by acrylates. *Contact Dermatitis* 2016; **75**: 180-184 [PMID: 27480513 DOI: 10.1111/cod.12578]

11 **Gitelis M**, Vigneswaran Y, Ujiki MB, Denham W, Talamonti M, Muldoon JP, Linn JG. Educating surgeons on intraoperative disposable supply costs during laparoscopic cholecystectomy: a regional health system's experience. *Am J Surg* 2015; **209**: 488-492 [PMID: 25586597 DOI: 10.1016/j.amjsurg.2014.09.023]

12 **Guzman MJ**, Gitelis ME, Linn JG, Ujiki MB, Waskerwitz M, Umanskiy K, Muldoon JP. A Model of Cost Reduction and Standardization: Improved Cost Savings While Maintaining the Quality of Care. *Dis Colon Rectum* 2015; **58**: 1104-1107 [PMID: 26445185 DOI: 10.1097/DCR.0000000000000463]

13 **Krpata DM**, Haskins IN, Rosenblatt S, Grundfest S, Prabhu A, Rosen MJ. Development of a Disease-based Hernia Program and the Impact on Cost for a Hospital System. *Ann Surg* 2018; **267**: 370-374 [PMID: 27906759 DOI: 10.1097/SLA.0000000000002093]

14 **Zygourakis CC**, Valencia V, Moriates C, Boscardin CK, Catschegn S, Rajkomar A, Bozic KJ, Soo Hoo K, Goldberg AN, Pitts L, Lawton MT, Dudley RA, Gonzales R. Association Between Surgeon Scorecard Use and Operating Room Costs. *JAMA Surg* 2017; **152**: 284-291 [PMID: 27926758 DOI: 10.1001/jamasurg.2016.4674]

15 **Childers CP**, Maggard-Gibbons M. Understanding Costs of Care in the Operating Room. *JAMA Surg* 2018; **153**: e176233 [PMID: 29490366 DOI: 10.1001/jamasurg.2017.6233]

16 **Sebesta MJ**, Bishoff JT. Octylcyanoacrylate skin closure in laparoscopy. *J Endourol* 2003; **17**: 899-903 [PMID: 14744358 DOI: 10.1089/089277903772036235]

**Footnotes**

**Institutional review board statement:** This study was reviewed and approved by Ascension St John Hospital Institutional Review Board, reference number 1165375.

**Clinical trial registration statement:** This study is registered at clinicaltrials.gov with an ID: NCT03891004.

**Informed consent statement:** All subjects in this study provided informed written consent prior to study enrollment.

**Conflict-of-interest statement:** All authors in this study do not have any conflict-of-interests.

**Data sharing statement:** Dataset available from the corresponding author at kyle.mackey@ascension.org.

**CONSORT 2010 statement:** The authors confirm that the manuscript was prepared according to the CONSORT 2010 statement.

**Open-Access:** This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/Licenses/by-nc/4.0/

**Manuscript source:** Unsolicited manuscript

**Corresponding Author's Membership in Professional Societies:** American College of Obstetricians and Gynecologists, No. 001114728I.

**Peer-review started:** March 9, 2020

**First decision:** September 21, 2020

**Article in press:**

**Specialty type:** Obstetrics and gynecology

**Country/Territory of origin:** United States

**Peer-review report’s scientific quality classification**

Grade A (Excellent): 0

Grade B (Very good): B

Grade C (Good): C, C

Grade D (Fair): 0

Grade E (Poor): 0

**P-Reviewer:** Borkow G, Bramhall SR, Neri V **S-Editor:** Zhang L **L-Editor: P-Editor:**

**Table 1 The stony brook scar evaluation scale**

|  |  |  |
| --- | --- | --- |
|  | **Scar category** | **Points** |
| Width | > 2 mm≤ 2 mm | 01 |
| HeightColor | Elevated/depressed in relation to surrounding skin FlatDarker than surrounding skinSame color/lighter than surrounding skin  | 0101 |
|  | Present | 0 |
| Hatch marks/Suture marks | Absent | 1 |
|  | Poor | 0 |
| Overall appearance | Good | 1 |

(Table reprinted from Fearmonti, 2010).

**Table 2 Patient characteristics stratified by subcuticular skin closure and tissue adhesive closure**

|  |  |  |  |
| --- | --- | --- | --- |
| **Demographics** | **Tissue adhesive *n* = 23, mean ± SD or *n* (%)** | **Subcuticular suture *n* = 24, mean ± SD or *n* (%)** | ***P* value** |
| Age (yr) | 58.3 ± 9.9 | 56.8 ±13.2 | 0.659 |
| Body mass index | 27.9 ± 5.8 | 28.7 ± 4.6 | 0.60 |
| Parity | 2.6 ± 1.5 | 2.5 ± 1.2 | 0.954 |
| Race |  |  |  |
| Caucasian |  19 (83) |  20 (83) | 1.0 |
| Black |  4 (17) |  4 (17) |  |