

ORIGINAL CONTRIBUTION

A Comparison of Cosmetic Outcomes of Lacerations on the Extremities and Trunk Using Absorbable Versus Nonabsorbable Sutures

Cena Tejani, MD, Adam B. Sivitz, MD, Micheal D. Rosen, MD, Albert K. Nakanishi, MD, Robert G. Flood, MD, Mathew A. Clott, MD, Paul G. Saccone, MD, and Raemma P. Luck, MD*

Abstract

Objectives: The primary objective was to compare the cosmetic outcomes of traumatic trunk and extremity lacerations repaired using absorbable versus nonabsorbable sutures. The secondary objective was to compare complication rates between the two groups.

Methods: This was a randomized controlled trial comparing wounds repaired with Vicryl Rapide and Prolene sutures. Pediatric and adult patients with lacerations were enrolled in the study. At a 10-day follow-up, the wounds were evaluated for infection and dehiscence. After 3 months, patients returned to have the wounds photographed. Two plastic surgeons blinded to the method of closure rated the cosmetic outcome of each wound using a 100-mm visual analog scale (VAS). Using a noninferiority design, a VAS score of 13 mm or greater was considered to be a clinically significant difference. We used a Student's t-test to compare differences between mean VAS scores and odds ratios (ORs) to compare differences in complication rates between the two groups.

Results: Of the 115 patients enrolled, 73 completed the study including 35 in the Vicryl Rapide group and 38 in the Prolene group. The mean (\pm SD) age of patients who completed the study was 22.1 (\pm 15.5) years, and 39 were male. We found no significant differences in the age, race, sex, length of wound, number of sutures, or layers of repair in the two groups. The observer's mean VAS for the Vicryl Rapide group was 54.1 mm (95% confidence interval [CI] = 44.5 to 67.0 mm) and for the Prolene group was 54.5 mm (95% CI = 45.7 to 66.3 mm). The resulting mean difference was 0.5 mm (95% CI = -12.1 to 17.2 mm; $p = 0.9$); thus noninferiority was established. Statistical testing showed no differences in the rates of complications between the two groups, but a higher percentage of the Vicryl Rapide wounds developed complications.

Conclusions: The use of absorbable sutures for the repair of simple lacerations on the trunk and extremities should be considered as an alternative to nonabsorbable suture repair.

ACADEMIC EMERGENCY MEDICINE 2014;21:637-643 © 2014 by the Society for Academic Emergency Medicine

Lacerations or open wounds are a common injury in the United States. The National Hospital Ambulatory Medical Care Survey published by the Centers for Disease Control and Prevention shows that approximately 6 million lacerations were evaluated in emergency departments (ED) in the United States

From the Department of Emergency Medicine (CT, ABS, MDR) and the Department of Surgery (MAC, PGS), Newark Beth Israel Medical Center, Newark, NJ; and the Department of Emergency Medicine, Cardinal Glennon Children's Medical Center (AKN, RGF), St. Louis, MO.

*Deceased.

Received October 28, 2013; revisions received December 24, 2013 and January 11, 2014; accepted January 11, 2014.

Presented at the Society for Academic Emergency Medicine Annual Meeting, Chicago, IL, May 2012.

Funded by a grant from the Newark Beth Israel Medical Center Foundation: \$1715.90 grant money spent to provide \$25.00 gift certificates for patients who completed the study.

The authors have no potential conflicts of interest to disclose.

Supervising Editor: Shahriar Zehtabchi, MD.

Address for correspondence and reprints: Cena Tejani, MD; e-mail: ctejani5@yahoo.com.

during the year 2009.¹ The majority of emergency physicians (EPs) are using nonabsorbable sutures to repair these wounds.²⁻⁴

Surgeons from various fields have used absorbable sutures for repair of wounds, and the published literature indicates that the cosmetic outcome is comparable to that of lacerations repaired using nonabsorbable sutures.⁵⁻¹⁰ Surgical wounds, however, differ from traumatic lacerations in a number of ways. Surgical incisions are linear and they occur under sterile situations. Lacerations that present in the ED are often jagged or varied in shape, and the level of wound contamination can be much greater depending on the mechanism of injury. The literature from ED studies has shown that lacerations on the face repaired with fast absorbing gut have good cosmetic outcomes,¹¹⁻¹⁴ but facial lacerations and extremity lacerations vary in a number of ways: the blood supply to the face is abundant, so wounds on the face heal quickly with minimal scarring; cuts on the extremities tend to be more contaminated, and tension on extremity wounds is greater than that on facial wounds.

This study compared the cosmetic outcome of lacerations of the extremities and trunk repaired in an ED setting using absorbable or nonabsorbable sutures. As lacerations on the extremities need sutures that stay in place longer and have greater tensile strength, we used Vicryl Rapide (Ethicon Endo-Surgery, Inc., Somerset, NJ). Vicryl Rapide is polyglactin 910, a braided undyed absorbable suture. The retention profile of Vicryl Rapide is such that at 5 days 50% of its retention strength is intact, and at 14 days 0% of its retention strength is intact. The full absorption profile for the suture is 42 days.¹⁵ A review of the literature indicates that there are, to our knowledge, no randomized prospective studies to date that have exclusively examined the cosmetic outcome of absorbable sutures on trunk and extremity lacerations that present to the ED.

Using absorbable sutures in the ED would confer many advantages. When absorbable sutures are used the patients do not need to return for suture removal. This means that adult patients would miss less time from work and pediatric patients would miss less time from school. As many of these follow-up visits take place in the ED, it could reduce ED crowding and wait times. Absorbable suture prices vary and are not always less expensive than nonabsorbable sutures, but analysis that has factored in patient missed days of work and ED overhead costs has found the use of dissolving material to be more cost-effective.¹⁶ Finally, for younger patients suture removal can be anxiety-provoking and stressful,¹⁷ so avoiding this follow-up procedure is beneficial for the pediatric population.

The primary objective of this study was to compare the cosmetic outcomes of lacerations repaired using absorbable and nonabsorbable sutures on the trunk and extremities. The secondary outcome was to compare the complication rates between the two groups. The complications evaluated included infection, dehiscence, and "train tracking." Train tracking is defined here as a scar that shows permanent sinus tracts or suture imprints. It occurs when sutures are left in place for too long, sutures are placed too tightly, or a suture that is too large is used.

METHODS

Study Design

This was a randomized prospective convenience sample clinical trial approved by the institutional review boards at Newark Beth Israel Medical Center (Newark, NJ) and the Cardinal Glennon Children's Medical Center (St. Louis, MO). The study was registered at clinicaltrials.gov (identifier NCT00933829). Informed written consent was obtained from the patient or from the parent of the patient by a pediatric ED fellow or a pediatric EP. In addition, written assent was obtained for any pediatric patient older than 7 years of age.

Study Setting and Population

The study was performed at two urban inner city hospitals in the United States and conducted from May 2010 until June 2012. At the primary study site patients were recruited from the adult and pediatric EDs, whereas at the secondary site, a children's hospital, patients came exclusively from the pediatric ED. The ED at the primary site sees 90,000 patients annually and the pediatric ED at the second site sees 42,000 patients annually.

Patients were recruited for the study only during daytime hours when study personnel were available for enrollment. Patients eligible for enrollment had linear, small (<8 cm), minimally contaminated (no visible dirt in wound) lacerations on the trunk or extremities. Patients were excluded from the study if any of the following characteristics were present: facial lacerations, visible dirt in the wound, delayed presentation to ED (>12 hours), nonlinear shape, bites, significant previous medical history, the use of daily steroids, wound over area of tension, or previous reaction to topical anesthetic.

Study Protocol

Using a random number generator in blocks of 10, the names of the suture types were placed by an independent physician in sealed consecutively numbered envelopes. After identifying an eligible patient and obtaining informed consent and assent, the physician who enrolled the patient picked an envelope.

No standard protocol for wound preparation, cleansing, or anesthesia was written for the study, and practitioners from these sites were advised to prepare the wounds using the practices that were already in place for their departments. Wounds were repaired by attending physicians, pediatric ED fellows, ED residents, or nurse practitioners. First-year residents performing repairs were supervised by more experienced practitioners, and medical students were not involved in this study. The local anesthetics used for wound repair included topical lidocaine, epinephrine, and tetracaine (LET) gel and local injections of 1% lidocaine with and without epinephrine. The absorbable suture group was repaired using either 4-0 or 5-0 Vicryl Rapide, and the nonabsorbable suture group was repaired using 4-0 or 5-0 Prolene (Ethicon Endo-Surgery, Inc.). All wounds were single-layer repairs, and simple interrupted sutures were placed. As Vicryl Rapide and Prolene appear different in color, practitioners who repaired the wounds were not blinded to enrollment. Patients were also not blinded to enrollment, as we needed to advise

patients in the Prolene group of the need for suture removal. Each patient received the standardized discharge instructions for wound care and follow-up used in the department where the repair took place.

Patients were asked to follow up in the ED after 10 days. At this time the wounds were evaluated for the secondary outcomes of infection and dehiscence. A wound was considered infected if antibiotics were prescribed at the follow-up visit, if there was chart documentation of erythema or tenderness surrounding the wound, or if purulent material was expressed from the wound. A wound was described as dehisced if it required the placement of additional sutures, tissue adhesive, or closure by secondary intention. Any patient whose wound was repaired by Prolene also underwent suture removal at this visit. If a wound was repaired using Vicryl Rapide, remaining intact sutures were left in place. Although the practitioner who evaluated the wounds for complications was not blinded to suture type, he was not involved in the project and unaware that the patients were enrolled in a study. Data were later abstracted from the electronic medical record (ED-IMS, Parsippany, NJ; or EPIC, Verona, WI) by the authors of the study. If a patient did not follow up for this visit, or chose to follow up at a primary care doctor's office, the patient was called after a 10-day period. During the phone call the patient or parent was asked the following questions: were antibiotics prescribed at a follow-up visit, did pus come out of the wound, did the wound open up, and did additional stitches or glue need to be used to close the wound? If the answer was yes for any of these questions, a result of infection or dehiscence was noted. The first author (CT) recorded all results on a Microsoft Excel spreadsheet.

Patients were then asked to return to the ED to have a photograph of the wound taken after a 3-month period. The decision to follow up at 3 months instead of 6 months came from the Food and Drug Administration's determination that a 3-month cosmetic outcome is the standard for evaluating success of laceration repair.^{18,19} As an incentive for return, the patients who completed the study were each given a \$25 dollar gift certificate. Photographs were taken using a Nikon Coolpix 4100 camera (Nikon Inc., Tokyo, Japan) and saved to a computer file. The camera was set on macro and pictures were taken about 12 inches from laceration with no zoom or flash. As some patients were not able to return for this visit they sent photos of their wounds via smart phones to the primary investigator's cell phone or e-mail account. If the photos were of equivalent quality as the pictures taken with the study camera protocol, they were used in the study and the gift certificate was mailed to the patient. The photos were rated for the primary outcome of cosmesis by two plastic surgeons who were blinded to treatment allocation. A 100-mm previously validated cosmetic visual analog scale (VAS) was used for rating purposes.²⁰⁻²² Results were recorded by the first author of the study on an Excel spreadsheet.

Photographs were also evaluated for the secondary outcome of train tracking. Labels indicating group assignment of the photos were removed and the first author of the study assigned the photograph as train tracking present or absent.

Data Analysis

For this trial, a noninferiority margin of 13 mm measured on the VAS was considered clinically equivalent. Previous studies have determined that the minimal clinically important difference between cosmetic ratings would be measured as 10 to 15 mm on the VAS.²⁰⁻²² Based on these data we used a standard deviation (SD) for cosmesis scores of 15 mm and calculated that with 30 subjects in each group, with an alpha error of 0.05, we would have 90% power to detect a 13-mm difference in cosmesis scores.²³ Using the confidence interval (CI) approach, noninferiority can be concluded if the absolute value for the lower boundary of the 95% CI for the difference in means between the two groups does not exceed 13 mm.

To compare demographic differences between groups and wound characteristics of each group we used a chi-square test for nominal variables and a risk ratio for ordinal variables. To compare the difference between the VAS mean values we used Student's t-test. To compare complication rates between the two groups we used chi-square test and calculated the odds ratio (OR). We used VassarStats to perform initial analysis and subsequently had the statistician at the primary study site review all work using Minitab.

RESULTS

During the study period, approximately 3,000 nonfacial traumatic lacerations were seen at the primary site and 1,600 at the secondary site. We enrolled 115 patients between May 2010 and June 2012. Two of the patients who were initially enrolled were excluded from the study, as there was no documentation of the enrollment group. Of the remaining 113 patients, 55 were in the Vicryl Rapide group and 58 were in the Prolene group. Forty patients did not complete the study. Of the 73 patients that completed the trial, 35 were in the Vicryl Rapide group and 38 were in the Prolene group (Figure 1).

Table 1 summarizes the demographic characteristics of patients who completed the study and those who were lost to follow-up. A larger percentage of the patients who were lost to follow-up were males, and the wounds for this group were also longer. Table 2 summarizes the demographic characteristics of the patients in the Vicryl Rapide group and the Prolene group. There were no significant differences between these two groups.

Table 3 summarizes the results of the mean VAS score. The mean VAS score for the Vicryl Rapide group was 54.1 (95% CI = 44.5 to 67.0) and that for the Prolene group was 54.5 mm (95% CI = 45.7 to 66.3). The difference between the two scores was 0.5 mm (95% CI = -12.1 to 17.2 mm). The absolute value of the lower end of the CI was less than 13 mm, indicating that Vicryl Rapide is not inferior to Prolene for suture repair. Four of the patients enrolled in the study had more than one laceration. When mean VAS scores for the Vicryl Rapide and the Prolene groups were compared incorporating these within-subject correlations, an equivalent difference between the two scores (0.5 mm) was calculated.

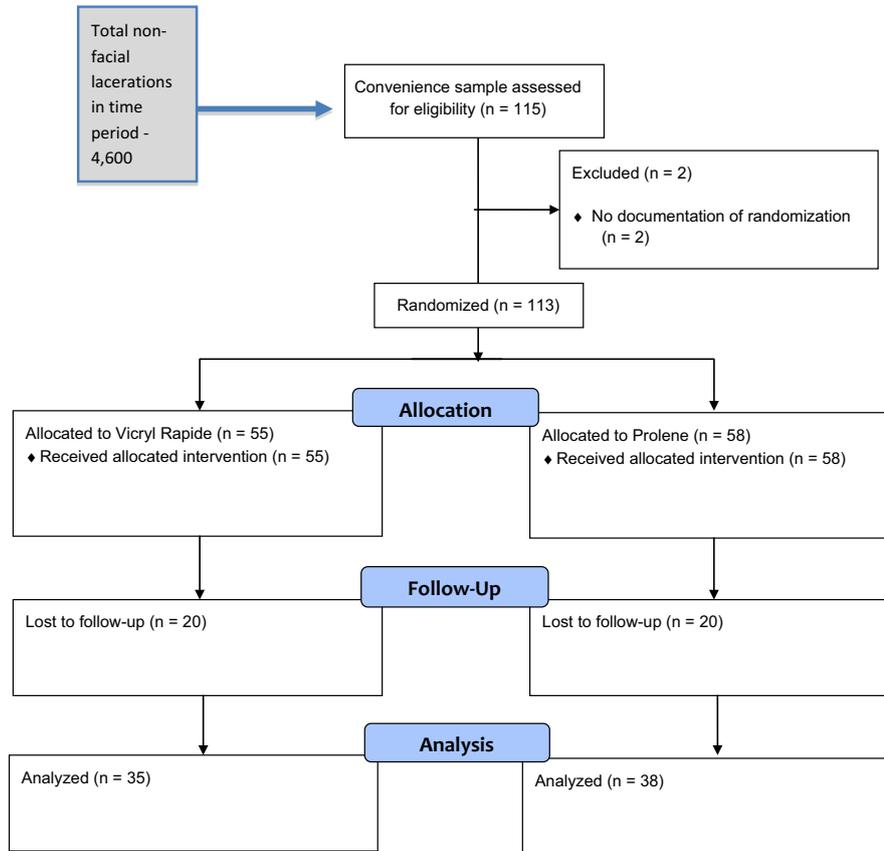


Figure 1. Study flow.

Table 4 summarizes the complication rates in our study. Twenty-four of the patients had complications recorded in our electronic medical record by health care workers, and 49 patients self-reported the complications. Three of the Vicryl Rapide wounds became infected and one of the Prolene wounds became infected (OR = 0.3, 95% CI = 0.03 to 2.9). There was no reported dehiscence in either group. Six of the Vicryl Rapide scars showed train tracking, while three of the

Prolene scars had this complication (OR = 0.4, 95% CI = 0.1 to 1.8).

DISCUSSION

Our results showed that there was no clinically significant cosmetic difference between traumatic lacerations repaired using absorbable versus nonabsorbable sutures, and for the criteria set for this study, wound

Table 1
Demographic Characteristics for Patients Who Completed the Study Compared With Those Who Were Lost to Follow-up

Demographic	Completed (n = 73)	Lost to follow-up (n = 55)	p-value*
Age (yr)	22.2 (±15.4)	17.8 (±12.5)	0.1
Sex			
Male	39 (53)	30 (75)	0.02
Female	34 (47)	10 (25)	
Race			
Black	61 (84)	33 (83)	0.6
White	12 (16)	7 (17)	
Length (cm)	2.8 (±1.1)	3.6 (±1.7)	0.02
Number of sutures	4.6 (±2.1)	4.6 (±2.0)	0.8
Number of layers	1	1	

Data are reported as n (%) or mean (±SD).
*Student's t-test/risk ratio.

Table 2
Demographic Characteristics for Patients Who Had Wounds Repaired With Vicryl Rapide Compared With Those Who Had Wounds Repaired With Prolene

Demographic	Vicryl Rapide (n = 35)	Prolene (n = 38)	p-value*
Age (yr)	23.1 (±16.9)	21.4 (±14.1)	0.6
Sex			
Male	16 (46)	23 (61)	0.4
Female	19 (54)	15 (39)	
Race			
Black	28 (80)	33 (87)	0.2
White	7 (20)	5 (13)	
Length (cm)	3.1 (±1.9)	2.6 (±1.0)	0.7
Number of sutures	4.9 (±1.8)	4.3 (±2.3)	0.2
Number of layers	1	1	

Data are reported as n (%) or mean (±SD).
*Student's t-test/risk ratio.

Table 3
Mean VAS scores for the Group Repaired With Vicryl Rapide Compared With the Group Repaired With Prolene

Suture	Mean VAS (mm)	(95% CI) \pm SD	p-value*
Vicryl Rapide (n = 35)	54.1	(44.5 to 67.0) \pm 7.6	0.9
Prolene (n = 38)	54.5	(45.7 to 66.3) \pm 26.4	
Difference	0.5	(-12.1 to 17.2)	

*Student's t-test.
VAS = visual analog scale.

evaluations for the two suture types were clinically equivalent. The advantages of using absorbable sutures include no need to return for follow-up care, decreased cost of care, and possibly decreased anxiety for children, as suture removal is not necessary. The results of this research combined with these intrinsic benefits of dissolvable sutures support the use of this material for traumatic laceration repair.

The use of absorbable sutures has been previously established for traumatic facial lacerations¹¹⁻¹⁴ and surgical repairs.⁵⁻¹⁰ Our study differs from previous literature as we exclusively examined trunk and extremity lacerations in an ED setting. Our study is consistent with previous literature, as we found no cosmetic difference between scars. Our study adds to the growing body of evidence that absorbable sutures are an appropriate alternative to nonabsorbable material for a wide variety of wounds.²⁴

Although we found little difference between our two study groups, the cosmetic ratings for both the Vicryl Rapide group and the Prolene group were much lower than ratings that have been made in other similar studies for facial lacerations. Our study focused on the trunk and extremities, which tend to heal more slowly and not as well as wounds on the face.^{2,25,26} Karounis et al.³ examined pediatric traumatic lacerations using absorbable and nonabsorbable sutures all over the body. The VAS scores in this study were also generally lower than ones from studies looking exclusively at facial laceration

repairs, but the study did not stratify ratings by body parts.

We chose a 3-month follow up time frame, as other studies suggest this is a sufficient time to allow for healing.^{18,19} As mentioned previously, most of the other studies evaluated the cosmesis of facial wounds that tend to heal faster. We speculate again that our overall scores were low as we looked at wounds on the trunk and extremities which tend to heal more slowly, and perhaps a 6-month follow-up would have allowed for suture tracks to heal, thereby improving overall VAS scores and reducing rates of train tracking.

As stated in the study protocol, we did not use a standard protocol for wound preparation, cleansing, or anesthesia, and practitioners were advised to use the practices that were already in place for their departments. Health care workers of varied levels of experience repaired the wounds, and we did not perform any specific training on how to use the Vicryl Rapide sutures. Although these inconsistencies in the protocol may have had an effect on the final cosmetic result, wound management and level of training of health care workers varies depending on the institution. Therefore, we feel that this aspect of our study expands the generalizability of our work. This also suggests that Vicryl Rapide sutures are easy to place and minimal familiarity with the material is required prior to use.

Our study lacked the power to detect significant differences with respect to complications rates. In our study 11% of the wounds repaired by Vicryl Rapide were infected and 3% of the Prolene repairs were infected. Published rates of non-bite wound infections vary from 2% to 12%, with most reports suggesting 5% to 7%,²⁷ but extremity lacerations tend to be more subject to infection, with average rates as high as 7%.²⁸ Irradiated polyglactin 910 is a synthetic braided suture degraded primarily by hydrolysis. Because this suture is synthetic and braided, there is a theoretical concern that it may interfere with wound healing resulting in a higher incidence of localized infection or dehiscence. However, other studies comparing Vicryl Rapide to nonabsorbable material for surgical wounds have shown no significant differences in complications rates.⁵⁻⁸ The majority of complication reporting was

Table 4
Complication Rates for Infection, Dehiscence, and Train Tracking for the Group Repaired With Vicryl Rapide Compared with the Group Repaired With Prolene

Complication	Vicryl Rapide (n = 35)	Prolene (n = 38)	p-value; OR (95% CI)
Infection			0.2; 0.2 (0.1-1.9)
Yes	4 (11) (0.6-21.4)	1 (3) (2.4-8.4)	
No	31 (89) (78.6-99.4)	37 (97) (91.6-102.4)	
Dehiscence			
Yes	0 (0)	0 (0)	
No	35 (100)	38 (100)	
Train tracking			0.2; 0.4 (0.1-1.8)
Yes	6 (17) (9.1-24.9)	3 (8) (2.6-13.4)	
No	29 (83) (75.1-90.9)	35 (92) (86.6-97.4)	

Data are reported as n (%) (95% CI).

done through a telephone conversation with the patient, which raises the concern that the rates of complication were not reliably reported. Although we acknowledge that patient self-reporting cannot be equated with the results that were recorded by health care workers in the electronic medical record, we felt that the questions posed to patients and parents were objective and the results recorded were accurate. Concerning the three Vicryl Rapide wounds that were infected, two cases were reported by parents at follow-up phone calls. One parent stated that oral antibiotics were needed, and the other stated that pus came out of the wound. In the third wound prophylactic antibiotics were prescribed at the repair for contamination as the patient had poured sugar in the wound prior to presentation. At the 10-day wound check minimal erythema was noted and the antibiotic was changed to a broader spectrum choice. Concerning the Prolene wound that was infected, erythema and exudate were documented by a health care provider at a 10-day wound check. Sutures were removed and a topical antibiotic was applied. No reports of dehiscence were documented for either study group.

As the Vicryl Rapide sutures stay in place longer than the fast absorbing gut, the possibility of train tracking exists. Although we did not have patients officially record the time it took for the Vicryl Rapide sutures to dissolve, anecdotally patients reported that these sutures remained in place for 1 to 3 weeks. In our study 17% of the Vicryl Rapide repairs and 8% of the Prolene repairs showed train tracking. Other studies comparing suture types have not specifically examined this complication, but studies that report scar hypertrophy as a component of cosmesis found no difference between absorbable and nonabsorbable sutures.²⁴ We would suggest that if Vicryl Rapide is used, discharge instructions to the patient should advise that suture material be removed if it stays in place longer than 10 to 14 days.

LIMITATIONS

This was a convenience sampling of eligible patients and we did not assess the existence of enrollment bias compared to the unenrolled population. The power calculation that we used determined a sample size for the primary outcome of cosmesis and lacked the power to detect significant differences with respect to the secondary outcomes of infection, dehiscence, or train tracking. Asking patients to return for wound checks and photographs proved to be difficult even with the monetary incentive. As a result, 49 of the patients self-reported complications of infection and dehiscence during a phone call, and a substantial number of patients were lost to follow-up. Finally, we did not control for the skill level and experience of the health care worker repairing the wound, a factor that might affect the final cosmetic appearance.

CONCLUSIONS

The use of Vicryl Rapide instead of nonabsorbable sutures for the repair of lacerations on the trunk and extremities should be considered by emergency physi-

cians, as it is an alternative that provides a similar cosmetic outcome. However, a larger trial of this type is needed to establish differences between complication rates between the two suture types.

References

- Centers for Disease Control and Prevention. National Hospital Ambulatory Medical Care Survey: 2009 Emergency Department Summary Tables. Table #11, p 15. Available at: http://www.cdc.gov/nchs/data/ahcd/nhamcs_emergency/2009_ed_web_tables.pdf. Accessed Mar 2, 2014.
- Deboard RH, Rondeau DF, Kang CS, Sabajj A, Mcmanus JG. Principles of basic wound care management in the emergency department. *Emerg Med Clin North Am* 2007;25:23–39.
- Karounis H, Gouin S, Eisman H, Chalut D, Pelletier H, Williams B. A randomized control trial comparing the long term cosmetic outcomes of traumatic lacerations repaired using absorbable plain gut vs nonabsorbable nylon sutures. *Acad Emerg Med* 2004;11:730–5.
- Selbst SM, Attia M. Minor trauma lacerations. In: Fleisher GR, Ludwig S (editors). *Textbook of Pediatric Emergency Medicine*, 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins, 2000, pp 1479–94.
- Blaydes JE, Berry J. Comparative evaluation of coated and uncoated polyglactin 910 in cataract and muscle surgery. *Ophthalmic Surg* 1980;11:790–3.
- Al-Qattan MM. Vicryl Rapide versus Vicryl suture in skin closure of the hand in children: a randomized prospective study. *J Hand Surg Br* 2005;30:90–1.
- Anatol TI, Roopchand R, Holder Y, Shin-Hong G. A comparison of the use of plain catgut, skin tapes and polyglactin sutures for skin closure: a prospective clinical trial. *J R Coll Surg Edinb* 1997;42:124–7.
- Greenberg JA, Lieberman E, Cohen AP, Ecker JL. Randomized comparison of chromic versus fast-absorbing polyglactin 910 for postpartum perineal repair. *Obstet Gynecol* 2004;103:1308–13.
- Sidebottom AJ, Grogan J, May P, Richardson D. Prospective comparison of methods of closure of the coronal flap after craniofacial surgery in children. *Br J Oral Maxillofac Surg* 2003;41:309–11.
- Missori P, Polli FM, Fontana E, Delfini R. Closure of skin or scalp with absorbable sutures. *Plast Reconstr Surg* 2003;112:924–5.
- Holger JS, Wandersee SC, Hale DB. Cosmetic outcomes in facial laceration repair with tissue adhesive, absorbable and nonabsorbable sutures. *Am J Emerg Med* 2004;22:254–7.
- Quinn JV, Drzewiecka A, Li MM, et al. A randomized controlled trial comparing tissue adhesive with suturing in the repair of facial lacerations. *Ann Emerg Med* 1993;22:1130–5.
- Parell GJ, Becker GD. Comparison of absorbable with nonabsorbable sutures in closure of facial skin wounds. *Arch Facial Plast Surg* 2003;5:488–90.
- Luck RP, Flood RG, Eyal DE, Saludades J, Hayes C, Gaughan J. Cosmetic outcomes between absorbable

- versus nonabsorbable sutures in pediatric facial lacerations. *Pediatr Emerg Care* 2008;4:137–42.
15. Ethicon, Inc. Product Catalog: Sutures, Absorbable. Available at: <http://www.ecatalog.ethicon.com/sutures-absorbable>. Accessed Mar 2, 2014.
 16. Osmond MH, Klassen TP, Quinn JV. Economic comparison of tissue adhesive and suturing the repair of pediatric facial lacerations. *J Pediatr* 1995;126:892–5.
 17. Farion KJ, Osmond MH, Hartling L, et al. Tissue adhesives for traumatic lacerations: a systematic review of randomized controlled trials. *Acad Emerg Med* 2003;10:110–8.
 18. Singer AJ, Thode HC Jr, Hollander JE. Research fundamentals: selection and development of clinical outcome measures. *Acad Emerg Med* 2000;7:397–401.
 19. Quinn J, Wells G, Sutcliffe T, et al. Tissue adhesive versus suture wound repair at 1 year: randomized clinical trial correlating early 3 month and 1 year cosmetic outcomes. *Ann Emerg Med* 1998;32:645–9.
 20. Quinn JA, Wells GA. An assessment of clinical wound evaluation scales. *Acad Emerg Med* 1998;5:583–6.
 21. Singer AJ. Clinical wound evaluation scales. *Acad Emerg Med* 1998;5:564–6.
 22. Quinn J, Drzewiecki A, Stiell I, Elmslie T. Appearance scales to measure cosmetic outcomes of healed lacerations. *Am J Emerg Med* 1995;13:229–31.
 23. Jones SR, Carley S, Harrison M. An introduction to power and sample size estimation. *Emerg Med J* 2003;20:453–8.
 24. Al-Abdullah T, Plint A, Fergusson D. Absorbable versus Non absorbable sutures in the management of traumatic lacerations and surgical wounds—a meta analysis. *Pediatr Emerg Care* 2007;23:339–44.
 25. Henry GL. Specific high emergency medicine risk issues. In: Henry GL, Sullivan DJ (editors). *Emergency Medicine Risk Management*. Dallas, TX: American College of Emergency Physicians, 1997: 475–94.
 26. Hollander JE, Blasko B, Singer AJ, Valentine S, Thode HC Jr, Henry MC. Poor correlation of short and long term cosmetic appearance of repaired traumatic lacerations. *Acad Emerg Med* 1995;11:983–7.
 27. Cummings P, Del Beccaro MA. Antibiotics to prevent infection of simple wounds: a meta-analysis of randomized studies. *Am J Emerg Med* 1995;4:396–400.
 28. McDonald P, Primiani N, Lund A. Are patients willing to remove, and capable of removing their own nonabsorbable sutures. *CJEM* 2012;14:218–23.