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Original Contribution

Comparison of cosmetic appearances after facial lacerations repaired by junior residents and experts☆

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ABSTRACT

Purpose: The technical factors which improve cosmetic outcomes and which need to be emphasized in education of junior residents have yet to be described. We compared cases in which suturing was performed by either junior emergency medicine residents or experts, in order to determine the focus of future education and training.
Methods: Wound registry data was reviewed and retrospectively analyzed from September 2015 to February 2016. Only patients who visited the emergency room with facial lacerations were enrolled, and their wound registry data sheets were reviewed. Practitioners were divided into junior resident and expert groups. We assessed the progress using the Stony Brook Scar Evaluation Scale (SBSES) 5–10 days following suturing.
Results: Sixty-six patients were enrolled; 43 (65.2%) were men. The median (interquartile range) cosmetic scores (SBSES scale) for suturing performed by junior residents or experts were 3 (2–4) and 5 (4–5), respectively ($p = 0.001$). The percentage of maximum scores for each SBSES category was significantly lower in the junior resident group than in the expert group for width (68% vs. 86%), hatch marks (68% vs. 93%), and overall appearance (41% vs. 80%) (all $p < 0.001$).
Conclusions: There were significant differences in scar widths and hatch marks, which were attributable to the skill level of the practitioner who performed the suturing of facial lacerations. Junior residents should be educated about maintenance of proper tension, atraumatic technique, and performing appropriate trimming or debridement.

1. Introduction

The incidence of facial wounds is between 4% and 7% of all accident and emergency visits [1,2]. Although wound recovery and prevention of infection are the primary goals of suturing, cosmetic outcomes greatly affect patient satisfaction, given that facial lacerations are present on an exposed part of the body [3]. Seventeen percent of patients with facial lacerations who visited the ED reported that the cosmetic aspect was the most important factor for satisfaction. In 33% of facial laceration cases, the cosmetic aspect was considered the top priority in treatment, with higher percentages observed in children and women [3].

The importance of quality suturing in the ED has increased in recent years, and suturing of facial lacerations in the ED is more frequently being performed by emergency medicine doctors. Most patients and guardians generally would prefer to receive sutures from a plastic surgeon in the ED; however, this may not be possible due to unavailability of a plastic surgeon. Depending on the circumstances of the hospital, various types of doctors may perform facial sutures. Suturing, when performed by a plastic surgeon in the ED, increases patient length of stay [1] as well as the work load of the plastic surgeons [4]. Zbar et al. suggested that this problem could be resolved if emergency physicians gained the necessary skills to treat simple facial lacerations, and Drolet et al. mentioned the importance of education and training of emergency physicians to reduce unnecessary transfers for plastics procedures. [5]. Therefore, factors directly influencing the quality of laceration repair should be identified and incorporated into Emergency Medicine training curriculum.

Lowe and Paoloni reported no difference in the satisfaction level with sutures performed by undergraduate practitioners and experts,

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using both short-term and long-term evaluations [6]. Conversely, in a short-term follow up study, Singer et al. reported that cosmetic outcomes of patients with facial lacerations differed based on the skill level of the treating practitioner and varied depending on whether a resident or an expert performed the suturing in the ED [7].

However, there have been no reports to date about the skill factors that affect cosmetic outcomes. It is possible that, with appropriate education, the skills of physicians not specialized in plastics procedures may mirror those of specialists in terms of cosmetic outcome. Therefore, the purpose of this study was to compare the cosmetic aspects of lacerations sutured by either a junior resident or an expert, in order to determine the focus of further education and training for improving the quality of care.

2. Participants and methods

2.1. Selection of participant groups

This retrospective observational study was performed from September 2015 to February 2016 at OO, OOO Hospital, with 42,000 annual attendances. This study was approved by the OOOO Institutional Review Board. For the purposes of this investigation, practitioners were allocated to either of two groups based on their level of experience. The junior resident group (JRG) consisted of first- or second-year-training emergency physicians (three per year, a total of six physicians), while the expert group (EG) was comprised of physicians who had >10 years of experience as certified emergency physicians and who were specialized in facial wounds (six expert physicians). There was no strict guidance as to which group should perform the repair of particular wounds. However, complicated wounds were routinely delegated to the EG for wound closure. In this study, only those patients who visited the emergency department with facial lacerations were enrolled, and their wound registry data were reviewed. Patients were excluded if they did not return to the outpatient clinic for scar evaluation or if the suturing was performed by physicians who were not part of the two groups evaluated in this study. The wound registry data included patient age and sex; wound type (laceration, bite, tear, abrasion, stab wound); wound location (head, neck, and trunk, extremity, genitalia); wound characteristics (size, shape, depth, angle of wound with a relaxed skin tension line, margin, degree of contamination, presence of foreign bodies); wound preparation (anesthesia type, use of irrigation, cleaning fluid, debridement method); and definitive wound management (type of stitch and suture material, dressing method, use of antibiotics).

2.2. Training programs for emergency medicine residents in wound repair

At this institution, it is mandatory for all emergency medicine residents to attend a wound care workshop, which is hosted by the Society for Clinical Procedures and Education, within 1 year of emergency medicine training. This workshop is comprised of a 1-h theory session and a 4-h hands-on session. The hands-on sessions are conducted in four steps, totaling 40 min for each session, using pig trotters. The curriculum included: i) basic knots and simple sutures; ii) suture techniques; iii) debridement, undermining, and eversion techniques; and iv) alternative suturing techniques. Junior residents are allowed to suture facial wounds 3 months after attending the wound management workshop. During these 3 months, the junior residents practice under the supervision of a wound specialist for at least 2 h a day for facial wound repairs.

2.3. Outcome evaluation

For all patients, the degree of scarring was evaluated 5–10 days after stitch removal, using the Stony Brook Scar Evaluation Scale (SBSES) (Table 1). An emergency medicine specialist who was not involved in the suturing procedure completed this evaluation.

Table 1
The Stony Brook Scar Evaluation Scale. This tool incorporates assessments of individual attributes, using binary responses (1 or 0) for each, as well as the overall appearance, resulting in a score ranging from 0 (worst) to 5 (best).

	Scar category	Points
Width	>2 mm	0
	≤2 mm	1
Height	Elevated/depressed in relation to surrounding skin	0
	Flat	1
Color	Darker than surrounding skin	0
	Same color or lighter than surrounding skin	1
Hatch marks/suture marks	Present	0
	Absent	1
Overall appearance	Poor	0
	Good	1

2.4. Analysis

Categorical variables are expressed as number (percentage) and were compared using Fisher's exact test. Continuous variables with a normal distribution are presented as mean (standard deviation), and continuous variables without a normal distribution are presented as median (interquartile range). Mann–Whitney *U* tests were conducted for comparisons of the two continuous variables. Data were analyzed using PASW/SPSS, version 18.0 (IBM Inc., Chicago, IL, USA) or Prism 6 (GraphPad Software Inc., La Jolla, CA, USA). A two-sided significance level of 0.05 was considered statistically significant.

3. Results

3.1. General characteristics of participants

During the study period, 1050 patients with lacerations were admitted to the emergency department, 420 of whom had lacerations of the face. Of these, 62 patients were excluded due to the practitioner's failure to record data in the wound registry; 117 because the primary repair was completed by a physician in another surgical subspecialty; and 175 due to loss of follow-up. Overall, 66 patients were enrolled. Twenty-two (33.3%) and 44 (66.7%) patients were included in the JRG and EG, respectively, for the purpose of this study (Fig. 1). There was no statistically significant difference in age between patients who were sutured by the JRG and those who were sutured by the EG. Moreover, there was no significant group difference between the sexes (Table 2).

3.2. Laceration characteristics on admission

3.2.1. Etiology of wound on admission

There were three types of etiology (bite, blunt, and stab wound) on admission. The most common cause of wounds was blunt trauma. There were no significant group differences in terms of the causes of the wounds.

3.2.2. Laceration length and width

The median laceration length was 2.0 (1.5–4.0) cm and 3.0 (2.0–5.0) cm in the JRG and EG, respectively, without significant differences ($p = 0.069$, Table 2). The median laceration width was 0.5 (0.3–1.0) cm and 0.9 (0.2–1.5) cm in the JRG and EG. There was no significant difference between the two groups ($p = 0.435$, Table 2).

3.2.3. Angle of laceration to the relaxed skin tension line

The relaxed skin tension line (RSTL) was divided into 30-degrees sections. There was no significant difference between the two groups ($p = 0.057$, Table 2).

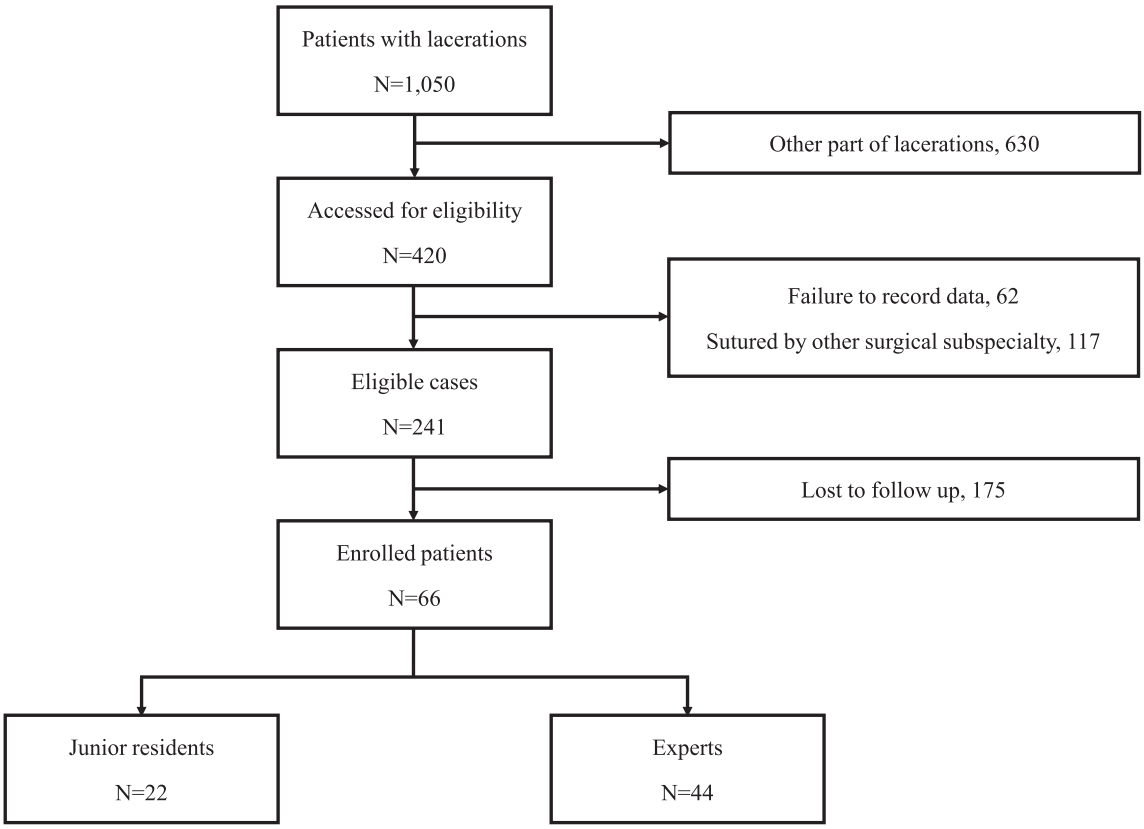

Fig. 1. Flow diagram of included patients.

3.2.4. Laceration depth

Laceration depth was divided into skin layers of the epidermis, dermis, subcutaneous, muscle, and periosteal layers, and there were no significant differences between the two groups in terms of this parameter ($p = 0.054$, Table 2).

3.2.5. Shape of laceration

Significant difference was shown in skin edge debridement and trimming ($p < 0.001$, Table 2).

3.3. Cosmetic outcomes

3.3.1. Total score of SBSES

At the follow-up examination, the median SBSES scores were significantly higher for the EG than for the JRG ($p < 0.001$, Fig. 2).

3.3.2. Comparison by subgroups of SBSES

There were no significant differences in height ($p = 0.490$) or color ($p = 0.264$). However, the percentage of maximum scores for each SBSES category was significantly lower in the JRG than in the EG in terms of width, hatch marks, and overall appearance ($p < 0.001$ for all; Fig. 3). Panels A and B in Fig. 4 show the sutures and their outcomes for a junior resident and an expert.

4. Discussion

The scar scoring systems that are in common use include the Vancouver Scar Scale, the Visual Analog Scale, Patients and Observer Scar Scale, Manchester Scar Scale, and SBSES Scale [8, 9]. The Vancouver Scar Scale is the most widely used evaluation tool but is predominantly used to score burns. The Visual Analog Scale is widely used as an evaluation tool after thermal suturing; however, it has the disadvantage of being a subjective tool. Therefore, the Manchester Scar Scale and SBSES have been implemented for objective evaluation of scars. The SBSES is a short-term scoring system that evaluates scars at 5–10 days after suture removal [9]. We used the SBSES for objective scar evaluation, given the short-term follow-up period.

In a 1996 study conducted by Singer et al., practitioners were classified as junior or senior, based on whether they were in their first year of training in the department of emergency medicine. The results of this study suggested that short-term cosmetic outcomes are significantly improved according to the proficiency of the practitioner [7]. However, a breakdown of the cosmetic scale according to the level of training did not show statistically significant differences in any individual category, although the junior practitioners tended to do worse in all categories. Conversely, in 2006, a study by Lowe and Paoloni, found no significant differences in cosmetic outcomes between short-term and long-term follow-up, regardless of the proficiency of the practitioner [6].

In the present study, there was no significant difference in the characteristics of patients who were sutured by residents or by experts (age, sex, wound location, wound depth, wound width, wound length, wound infection, and wound irrigation). However, there was a significant difference in the median SBSES score (3 [2−4] vs. 4 [4−5] points) between the cases in which suturing was performed by junior residents and those in which suturing was performed by experts ($p = 0.001$). Although wound characteristics were not statistically different, lacerations treated by physicians in the JRG were clinically less complicated than those treated by physicians in the EG. This could have contributed to poorer outcomes as junior residents may have used less time and concentration to repair seemingly less complicated lacerations. Meaningful differences in scar width, hatch marks, and overall appearance were observed for each SBSES category. The overall appearance, scar width, and hatch marks are affected by tension on the wound site during suturing [8-13]. The overall appearance and width of a scar are also reportedly related to proficiency in trimming or debridement, as

Table 2
General characteristics of included patients

Characteristic	Total (n = 66)	Junior residents (n = 22)	Experts (n = 44)	*p*-value†
Age (y)				0.811
Median	26.0	25.0	26.0	
Interquartile range	8.1–47.0	17.0–50.0	7.6–46.5	
Male sex, n (%)	43 (65.2)	16 (72.2)	27 (61.4)	0.421
Etiology of laceration, n (%)				1.000
Bite	3 (4.5%)	1 (4.5%)	2 (4.5%)	
Blunt wound	61 (92.4%)	20 (90.9%)	41 (93.2%)	
Stab wound	2 (3.0%)	1 (4.5%)	1 (2.3%)	
Laceration length (cm)				0.069
Median	3.0	2.0	3.0	
Interquartile range	2.0–4.0	1.5–4.0	2.0–5.0	
Laceration width (cm)				0.435
Median	0.5	0.5	0.9	
Interquartile range	0.2–1.1	0.3–1.0	0.2–1.5	
Angle to the RSTL (>30°), n (%)	23 (34.8%)	4 (18.1%)	19 (43.1%)	0.057
Laceration depth				0.054
Epidermis	4 (6.0%)	0 (0%)	4 (9.0%)	
Dermis	7 (10.6%)	1 (4.5%)	6 (13.6%)	
Subcutaneous	43 (74.2%)	20 (90.9%)	24 (54.5%)	
Muscle	6 (9.0%)	1 (4.5%)	6 (13.6%)	
Periosteum	4 (6.0%)	0 (0%)	4 (9.0%)	
Shape of laceration				0.193
Linear	48 (72.7%)	19 (86.3%)	29 (65.9%)	
Jagged	8 (12.1%)	3 (13.6%)	5 (11.4%)	
Semicircular	3 (4.5%)	0 (0%)	3 (6.8%)	
Avulsion	1 (1.5%)	0 (0%)	1 (2.3%)	
Crushed	6 (9.0%)	0 (0%)	6 (13.6%)	
Wound irrigation, %	95.5%	100%	93.2%	0.545
Debridement/trimming, n (%)	30 (45.4%)	3 (13.6%)	27 (61.3%)	<0.001
Antibiotics given, n (%)				0.851
None	3 (4.5%)	1 (4.5%)	2 (4.5%)	
Topical only	1 (1.5%)	0 (0%)	1 (2.3%)	
P.O. only	19 (28.8%)	7 (31.8%)	12 (27.3%)	
Both	43 (65.2%)	14 (63.6%)	29 (65.9%)	
Wound infection, n (%)	2 (3%)	1 (4.5%)	1 (2.3%)	0.559

Abbreviations: RSTL, relaxed skin tension line. PO, per os.

well as in proficiency in instrument handling [14-16]. On the other hand, lacerations treated by the physicians in the EG were clinically more complicated than those treated by physicians in the JRG, although there was no statistically significant difference. This may have contributed to the decrease in the time and concentration required for the repair of lacerations by the JRG, which may have resulted in poor outcomes.

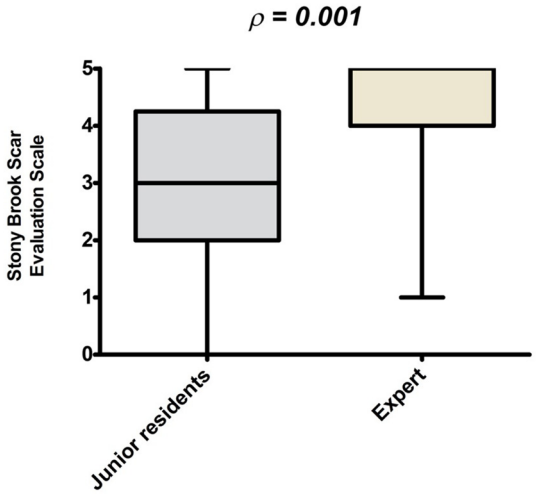

Fig. 2. Comparisons of the Stony Brook Scar Evaluation Scale scores between the junior resident and expert groups, using the Mann–Whitney *U* test.

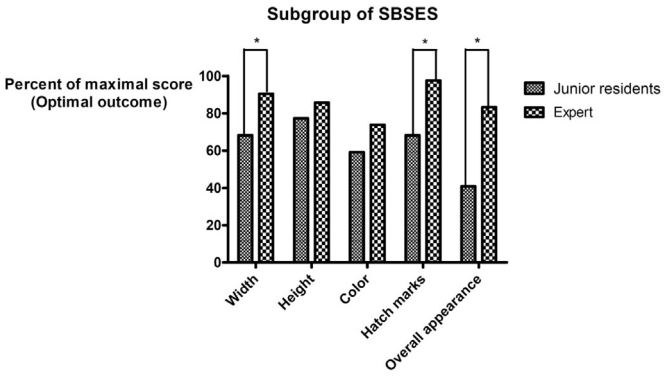

Fig. 3. The percentage of wounds with a maximal score for each of the Stony Brook Scar Evaluation Scale categories SBSES, Stony Brook Scar Evaluation Scale. *$p < 0.05$.

Proper wound closure requires an understanding of certain basic principles. First, sutures should be placed carefully and with the proper amount of tension to help promote healing. Second, the layer of the wound should be matched evenly, and each layer should be closed separately. Third, the epidermal edges of the wound must be everted. Fourth, the tissue should be handled gently and should not be squeezed or twisted too tightly with the instrument. Finally, devitalized, severely contaminated or jagged wounds require debridement or trimming to create a more linear and smooth edge, which is better for approximation and good healing of a wound closed with sutures [14-16].

In scar prevention, the single most important modifiable factor is wound tension during the proliferative and remodeling phases [10]. Closure with excessive tension is one of the most common reasons for increased scar width, while excessive wound tension when tying the knot can cause tissue constriction, increasing the risk for larger, more obvious hatch marks [10-13]. In contrast, a lack of tension in the suture may lead to suture release and wound widening, resulting in poor cosmetic outcomes after suturing [10,12,13].

To maintain proper tension after suturing, the condition of the tissue at the wound site must also be considered. Edema of the acute wound site, as well as the subsequent loss of swelling in the suture site can cause loosening of tensile strength [12,13,17]. Therefore, in order to prevent excessive tension or loosening of tensile strength in laceration repair, the process of the wound healing must be understood. However, it is difficult for novices to gauge optimal wound tension and to make adjustments for wound swelling and its release.

Sutures should be placed as close to the wound edge as possible (2–3 mm) in order to avoid excessive tension on the wound [15,16], but novices may find it difficult to adhere to this principle. Inexperienced physicians tend to suture more widely.

Traumatic handling of instruments, such as tooth forceps, also affects the scar width and the overall appearance. Wounds that are excessively traumatized during closure may develop wound dehiscence or undergo skin-edge necrosis, leaving unsightly scars. It is vitally important to avoid rough tissue handling and the use of crushing instruments [14,15]. Traumatic tissue handling can destroy the vascular plexus, while keeping tissue trauma to a minimum promotes faster healing. Throughout the procedure, the physician must handle all tissues very gently and as little as possible. Junior residents tend to cause more crushing injury when handling lacerated tissue because they lack tactile experience.

Sometimes jagged edges may simply require trimming. Burst or jagged laceration edges may be repaired with debridement or trimming to create a more linear and smooth edge, which allows better approximation of the wound for closure with sutures [11,14-16,18]. These techniques minimize the scar, especially its overall appearance and width. Debridement or trimming involves the removal of all devitalized and contaminated tissues with maximal preservation of critical anatomical

Fig. 4. A. Case of wound closure performed by junior resident. (a) A 19-year-old male visited the emergency department for repair of a forehead laceration caused by a crushing injury. (b) A junior resident repaired the wound without trimming or debridement. He inserted sutures without considering the swelling of the wound. (c) Wound at 5 days after suture removal. Loosening of the repair site and unremoved devitalized tissue created a wide, dry scab with an unpleasant overall appearance. B. Case of wound closure performed by an expert. (a) A 42-year-old male visited the emergency department for repair of a jagged eyelid laceration. (b) An expert repaired the wound after trimming the devitalized and jagged tissue. (c) Wound at 5 days after suture removal. No dry scab is visible. D. Wound at 6 months after suture removal.

structures [11,14-16,18]. Debridement or trimming of skin edges should be kept to a minimum, unless the tissue is obviously dead [14-16]. Because of the excellent blood supply of the face, tissue that seems ischemic often survives. This takes only a little time and often greatly improves the final appearance after the wound has healed. In this study, junior residents tended to avoid debridement or trimming, as compared to experts ($p < 0.001$; Table 2). Of the patients included in the study, all but two patients with stab wounds did not require trimming of the lacerations. We assume that junior residents are unfamiliar with trimming and debridement, and thus it is likely that they will directly close such lacerations, irrespectively.

In the present study, significant differences were detected in scar widths and hatch marks according to the skill of the practitioner during suturing of facial lacerations in the ED. Both scar widths and hatch marks are affected by tensile strength. Scar width is also related to proficiency in trimming or debridement as well as to proficiency in instrument handling. Therefore, junior emergency medicine residents should be trained in maintaining proper suture tension and the treatment of lacerations. The appropriate atraumatic handling of instruments and trimming or debridement should be emphasized in practicing laceration repair.

The present study has several limitations. First, there was a lack of diversity, as the research was conducted at a single center. Second, the present study was a pilot study involving only few cases and a short follow-up period. A large number of patients were lost to follow-up; the results of the study might have been different if data from all eligible facial lacerations had been available for analysis. Short-term and long-term follow-up of wound healing may have yielded different results. Therefore, additional studies using a larger number of cases and long-term follow-up period are required. Third, the extent of wound management could not be confirmed. After being sutured, patients were instructed to disinfect their wound daily and apply or consume prescribed medication. However, there were cases in which wounds were not managed properly. Fourth, the small number of physicians in the JRG can be regarded as a limitation of this study. Therefore, additional multicenter studies, with more JRG and EG physicians are needed.

5. Conclusion

The findings of this study suggest that it is necessary to educate practitioners about the necessity of investing time and effort to acquire suturing experience. Education and training should focus on the practitioners' ability to control wound tension. Handling of instruments atraumatically (especially wound edge handling) and trimming or debridement of the wound edge during repair should be emphasized.

Conflict of interest statement

No authors have any conflicts related to this work.

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References

[1] Lee SJ, Cho YD, Park SJ, et al. Satisfaction with facial laceration repair by provider specialty in the emergency department. Clin Exp Emerg Med 2015;2:179–83.
[2] Ong TK, Dudley M. Craniofacial trauma presenting at an adult accident and emergency department with an emphasis on soft tissue injuries. Injury 1999;30:357–63.
[3] Singer AJ, Mach C, Thode Jr HC, et al. Patient priorities with traumatic lacerations. Am J Emerg Med 2000;18:683–6.
[4] Zbar R, Monico E, Calise A. Consultation for simple laceration repair when on-call in the emergency department: potential quagmire. Plast Reconstr Surg Glob Open 2017;12:e1428.
[5] Drolet BC, Tandon VJ, Ha AY, et al. Unnecessary emergency transfers for evaluation by a plastic surgeon: a burden to patients and the health care system. Plast Reconstr Surg 2016;137:1927–33.
[6] Lowe T, Paoloni R. Sutured wounds: factors associated with patient-rated cosmetic scores. Emerg Med Australas 2006;18:259–67.
[7] Singer AJ, Hollander JE, Valentine SM, Thode Jr HC, Henry MC. Association of training level and short-term cosmetic appearance of repaired lacerations. Acad Emerg Med 1996;3:378–83.
[8] Nguyen TA, Feldstein SI, Shumaker PR, Krakowski AC. A review of scar assessment scales. Semin Cutan Med Surg 2015;34:28–36.
[9] Singer AJ, Arora B, Dagum A, Valentine S, Hollander JE. Development and validation of a novel scar evaluation scale. Plast Reconstr Surg 2007;120:1892–7.
[10] Son D, Harijan A. Overview of surgical scar prevention and management. J Korean Med Sci 2014;29:751–7.

[11] Al-Shaqsi S, Al-Bulushi T. Cutaneous scar prevention and management: overview of current therapies. Sultan Qaboos Univ Med J 2016;16:e3–8.
[12] Muffly TM, Boyce J, Kieweg SL, et al. Tensile strength of a surgeon's or a square knot. J Surg Educ 2010;67:222–6.
[13] Moody BR, McCarthy JE, Linder J, et al. Enhanced cosmetic outcome with running horizontal mattress sutures. Dermatol Surg 2005;31:1313–6.
[14] Terry W. Plastic surgery made easy—simple techniques for closing skin defects and improving cosmetic results. Aust Fam Physician 2017;35:492–6.
[15] Reichman EF. Emergency medicine procedures. 2nd ed. New York: McGraw-Hill; 2013; 623–6.
[16] Singer AJ, Quinn JV, Thode Jr HC, et al. Determinants of poor outcome after laceration and surgical incision repair. Plast Reconstr Surg 2002;110:429–35.
[17] Klink CD, Binnebösel M, Alizai HP, et al. Tension of knotted surgical sutures shows tissue specific rapid loss in a rodent model. BMC Surg 2011;21:36.
[18] Min JH, Park KH, Choi HL, et al. Usefulness of direct W-plasty application to wound debridement for minimizing scar formation in the ED. Am J Emerg Med 2017;35:1804–9.