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ORIGINAL RESEARCH

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Randomized controlled trial comparing cosmetic suturing with polydioxanone sutures to conventional interrupted sutures for maxillofacial soft tissue wound closure in children

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Abstract

Background: In the process of wound healing after trauma, continuous reduction of the tension of subcutaneous tissue helps to reduce the formation of scars and achieve better cosmetic results. This study aimed to investigate the cosmetic effect of polydioxanone sutures combined with cosmetic suturing in maxillofacial soft tissue wound closure in children. **Methods**: 104 children, aged 3 to 10 years with maxillofacial soft tissue trauma, were randomly assigned to either an intervention group or a control group. The polydioxanone sutures combined with cosmetic suturing was used to close the wound, and the traditional interrupted suturing was used as the control. In the two group, the scar quality was evaluated by Vancouver Scar Scale (VSS), and the scar width was measured to evaluate the cosmetic effect of the wound. **Results**: The surgical time was significantly longer in the intervention group compared to the control group. At 3 months and 6 months follow-up, the VSS score of the observation group was significantly lower than that of the intervention group ($p < 0.05$), reflecting better scar quality. At 6 months follow-up, the scar width of the intervention group was significantly smaller than that of the control group ($p < 0.05$). **Conclusions**: The results in this paper suggests that the use of polydioxanone sutures combined with cosmetic suturing in children's facial soft tissue trauma can obtain continuous tension reduction effect at the wound, reduce scar tissue hyperplasia and obtain ideal cosmetic effect, while improving the overall quality of pediatric wound treatment. **Clinical Trial Registration**: The registration number in the Chinese Clinical Registration Center was ChiCTR2400094703.

Keywords

Cosmetic suture; Polydioxanone; Maxillofacial trauma; Children

1. Introduction

Children are particularly vulnerable to trauma in daily life due to factors such as limited awareness of potential dangers and underdeveloped self-protection mechanisms. The maxillofacial region, due to its prominent exposure, is particularly susceptible to injuries, which often result in varying degrees of soft tissue damage [1, 2]. The complex anatomical structure of the maxillofacial area presents unique challenges in tissue repair, increasing the risk of infections, delayed healing and scarring [3]. These injuries can severely impact the aesthetic appearance of the affected individuals. The formation of scars, in particular, can negatively affect not only the physical appearance but also the psychological well-being of children, potentially leading to long-term emotional and mental consequences [4].

Maxillofacial wounds in children require careful management optimize both functional recovery and aesthetic outcomes while minimizing the risk of excessive scar formation. Current clinical approaches include the use of topical treatments [5, 6], laser therapy [7, 8] and techniques to reduce skin tension [9], all of which aim to minimize scarring. However, technique employed in wound closure is particularly important for reducing scar formation. While commonly used, conventional interrupted suturing often lacks the precision needed to achieve optimal aesthetic results, leading to visible scarring and possible secondary deformities. In response to these challenges, cosmetic suturing techniques have been developed to improve wound closure, which allows for meticulous trimming and layered suturing, and helps reduce subcutaneous tension and promote better aesthetic outcomes the healing process [10]. Despite these advances, traditional subcutaneous sutures often fail to provide sustained tension reduction, especially in the complex facial structures of pediatric patients, where muscle alignment, motion and varying skin characteristics pose additional difficulties [11]. Polydioxanone sutures, a type of single-strand absorbable suture, offer several advantages

for pediatric maxillofacial wound closure and are known for their slow absorption rate high tensile strength and resilience. These sutures provide prolonged support beneath the skin, helping to resist shear forces that can lead to excessive scarring [12, 13]. Furthermore, polydioxanone sutures are impregnated with triclosan, an antimicrobial agent that reduces bacterial colonization and minimizes the risk of postoperative infection [13, 14].

In this study, we hypothesize that employing polydioxanone sutures combined with cosmetic suturing techniques for soft tissue wound closure in the pediatric maxillofacial region would result in reduced local scar hyperplasia and improved aesthetic outcomes post-surgery. To test this, we applied cosmetic suturing techniques to close pediatric maxillofacial trauma wounds incorporating subcutaneous suturing with polydioxanone sutures to achieve sustained tension reduction at the wound site for investigating the cosmetic efficacy of utilizing polydioxanone sutures in combination with cosmetic suturing techniques for closing soft tissue wounds in the pediatric maxillofacial region. By comparing the outcomes with those of traditional interrupted suturing techniques, we assessed the cosmetic effects of each approach. Overall, the findings could hold significant implications for minimizing scar hyperplasia following maxillofacial trauma in children and enhancing the cosmetic outcomes of reparative procedures.

2. Materials and methods

2.1 Patients

This study enrolled 104 children with maxillofacial trauma requiring debridement and suturing, who were admitted to the Burn and Plastic Surgery Department of Wuxi Children's Hospital between January 2022 and June 2023. The inclusion criteria were as follows: (1) the presence of skin and soft tissue lacerations in the exposed maxillofacial region extending beneath the muscular layer, with notable wound tension, and a parental request for plastic surgery and cosmetic sutures; (2) the absence of preoperative anesthesia or surgical contraindications based on routine examinations; (3) no significant skin tissue defects; (4) surgery performed within 24 hours of injury; and (5) willingness to adhere to scheduled follow-up appointments. The exclusion criteria were as follows: (1) the patient combined with other facial organ damage; and (2) the patient with systemic injury. The patients were randomly assigned to either the intervention group, which underwent wound closure using polydioxanone sutures combined with cosmetic suturing techniques or the control group, which received wound closure using conventional interrupted suturing. A computer-generated random sequence was used for allocation, with 52 patients in each group.

2.2 Procedure

2.2.1 The preoperative debridement process

After successful induction of general anesthesia, both groups underwent standard surgical debridement in the supine position. The wound surface and surrounding skin were irrigated with physiological saline, disinfected with iodine and covered with a sterile drape. For thorough cleansing, the wound was irrigated sequentially with hydrogen peroxide, iodine and physiological saline to remove any foreign bodies. Necrotic tissue was excised, and irregularly contoured skin was trimmed as necessary. If present, hematomas were removed. Hemostasis was achieved through electrocoagulation for larger bleeding vessels, while smaller vessels were sutured.

2.2.2 Intraoperative operation process

Intervention group: The intervention group comprised 52 patients who underwent a layered tension reduction cosmetic suture technique. Initially, 5-0 polydioxanone sutures were used to intermittently suture the muscle layer, followed by 6-0 polydioxanone sutures for intermittent suturing of the subcutaneous tissue to ensure ensuring a tension-free closure. Finally, continuous locking sutures with 7-0 non-absorbable sutures (blue polypropylene monofilament, COROLENE® Peter France) were used for epidermal repair. A sterile dressing was then applied to cover the sutured wound.

Control group: The control group included 52 patients who underwent traditional interrupted suturing. Depending on wound tension, either 5-0 or 6-0 non-absorbable sutures (antibacterial polydioxanone, ETHICON® America) were selected to suture an entire skin layer using the intermittent suturing technique. After suturing, the wound was covered with a sterile dressing.

2.2.3 Postoperative treatment

Maintaining a clean and dry surgical area is essential during the procedures. Oral antibiotics were administered for three days postoperatively. Wound dressings were changed on the third and fifth postoperative days, and superficial sutures were removed on the seventh day. Any complications, including hematoma, infection or suture reactions, were promptly documented and managed as necessary.

2.3 Assessment

The primary objective of this study is to validate the hypothesis that the combined use of polydioxanone sutures and cosmetic suturing techniques for wound closure in pediatric patients with maxillofacial trauma yields superior healing outcomes compared to traditional interrupted suturing. Specifically, we aim to demonstrate that this combined approach results in reduced postoperative scar hyperplasia and improved aesthetic outcomes.

To achieve this, the patients were evaluated at 1, 3 and 6 months postoperatively using, the Vancouver Scar Rating Scale (VSS), which assesses scar, namely color, thickness, softness and vascular distribution, with higher VSS scores indicating more severe scar hyperplasia [15]. For a more detailed analysis, the scars were divided into four equal sections, and measurements were taken at three predetermined locations (at the 1/4, 1/2 and 3/4 positions). Scar width was measured using a vernier caliper at these points, and the average value was recorded for assessment.

Postoperative complications were initially assessed one week after surgery by an experienced attending physician. This assessment focused on identifying the presence of wound infection, bleeding and exudation. In addition, at the

one-month follow-up, wound healing was further evaluated by examining the extent of wound induration and the response of the sutures.

At six months postoperatively, a satisfaction survey was given to the parents of the patients. The survey classified outcomes as follows "Very Satisfied" (indicating excellent functional recovery, satisfactory appearance and absence of noticeable scars), "Satisfied" (indicating good functional recovery, satisfactory appearance and minimal scarring) or "Dissatisfied" (indicating inadequate functional recovery, disfigured appearance and prominent scars). The satisfaction rate was calculated according to the following formula: Satisfaction Rate = [(Very Satisfied + Satisfied)/Total number of cases] × 100%.

2.4 Statistical analysis

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS), version 13 (IBM Corp, Armonk, NY, USA). Categorical variables were expressed as rates (%) and analyzed using the chi-square test, while quantitative data were presented as mean ± standard deviation (SD) and compared using a *t*-test. A *p*-value of < 0.05 was considered indicative of statistical significance.

3. Results

All 104 patients enrolled in this study completed follow-up assessments throughout the study duration. The baseline characteristics of the two groups, including gender, age, weight and incision length, were well balanced, as shown in Table 1. The average surgical time was 46.47 ± 22.63 seconds in the intervention group and 38.74 ± 13.31 seconds in the control group. A *t*-test comparison between the groups yielded a *t*-value of 11.4, indicating that the surgical time was significantly longer in the intervention group than in the control group ($p < 0.001$, $p < 0.05$).

Regarding wound location distribution, we observed that frontal area wounds were the most common, with 25 cases in the intervention group and 34 cases in the control group (Table 2). A chi-square test comparison between the two groups resulted in a chi-squared value of 3.17, indicating no statistically significant difference ($p = 0.075$, $p > 0.05$).

Scar quality was assessed using the Vancouver Scar Rating Scale (VSS) (Table 3). At the 1-month follow-up, no statistically significant difference was observed in VSS scores between the two groups. However, at the 3-month and 6-month follow-ups, the intervention group exhibited significantly lower VSS scores, indicating better scar quality compared to the control group.

Scar width measurements between the two groups are summarized in Table 4. At the 1-month and 3-month follow-ups, no significant differences were observed. However, at the 6-month follow-up, the intervention group demonstrated significantly smaller scar widths than the control group, with a statistically significant difference ($p < 0.001$, $p < 0.05$).

Postoperative complications were also evaluated, and the results showed that one week after surgery, neither group exhibited signs of infection, bleeding or exudation. At the 1-month follow-up, no wound induration or suture reactions were observed in either group.

At the 6-month follow-up, a satisfaction survey was conducted among the parents of patients in both groups. The satisfaction rate was 98.1% in the intervention group and 94.2% in the control group. A chi-square test yielded a chi-squared value of 1.040, indicating no statistically significant difference between the groups ($p = 0.308$, $p > 0.05$).

4. Discussion

Physical appearance plays an essential role in social interactions, and facial scarring can have profound psychological effects, indicating that timely wound closure using appropriate surgical suturing techniques is important in the management of skin and soft tissue injuries in the maxillofacial region. Scars resulting from facial trauma can lead to significant emotional distress, contributing to anxiety, depression and diminished self-esteem, particularly in children and adolescents. Therefore, minimizing scar formation is not only important for aesthetic outcomes but also for preserving psychological well-being self-confidence and overall social integration.

Various approaches have been explored to mitigate scar hyperplasia, including pharmacological treatments [5, 6], laser therapy [7, 8] and skin tension-reducing techniques [9]. However, these methods often fail to effectively prevent scar widening. Mechanical interventions, such as adhesive strips and skin tension-reducing devices, can help alleviate wound tension

TABLE 1. Characteristics of patients.

Groups	Number of samples	Sexuality		Age[1] (yr)	Weight[1] (kg)	Wound length[1] (mm)	Operation time[1] (s)
		Male	Female				
Intervention group	52	32	20	7.17 ± 3.01	24.60 ± 8.77	4.67 ± 1.68	46.47 ± 22.63
Control group	52	31	21	7.00 ± 2.96	24.11 ± 9.06	5.10 ± 2.88	38.74 ± 13.31
t/χ^2		0.040		0.683	1.281	−1.914	11.400
p value		0.841		0.495	0.200	0.056	<0.001

[1] *The measurement data are expressed by means ± SD.*
p value: p < 0.05 considered as statistically significant.

TABLE 2. Distribution of wound location in two groups of patients.

Wound location	Intervention group	Control group
Face	9	4
Frontal area	25	34
Nasal root	2	2
Eyelid	2	3
Eyebrow arch	12	7
Temporal region	1	0
Multiple parts	1	2
Total	52	52

TABLE 3. Vancouver Scar Scale score in the intervention group and the control group.

Time	Intervention group[1]	Control group[1]	*t*	*p* value
1-month	1.40 ± 0.497	1.47 ± 0.612	−0.566	0.573
3-month	1.78 ± 0.634	2.12 ± 0.591	−3.649	<0.001
6-month	1.77 ± 0.701	2.39 ± 0.588	−6.669	<0.001

[1]*Expressed as means ± SD.*
p value: $p < 0.05$ considered as statistically significant.

TABLE 4. Scar width in the intervention group and the control group.

Time	Intervention group[1] (mm)	Control group[1] (mm)	*t*	*p* value
1-month	0.287 ± 0.098	0.360 ± 0.117	−1.862	0.073
3-month	0.582 ± 0.119	0.644 ± 0.145	−1.791	0.078
6-month	0.608 ± 0.126	0.900 ± 0.180	−7.728	<0.001

[1]*Expressed as means ± SD.*
p value: $p < 0.05$ considered as statistically significant.

and minimize scar formation. Despite their benefits, their application in the maxillofacial region is often limited due to the complex anatomical structure and the variability of facial skin, particularly in areas near the eyes, nose and mouth. Additionally, the prolonged use of these devices in children is often impractical due to issues such as poor compatibility, skin irritation and allergic reactions, which hinder their long-term efficacy. Given these challenges, early intervention is essential to optimize wound healing and minimize scar formation. Key strategies include meticulous wound cleansing, careful selection of suturing techniques and appropriate wound coverage and protection. Among these measures, achieving tension-free wound healing remains one of the most effective strategies for reducing scar hyperplasia [16, 17].

The most used employed technique for wound closure following trauma is full-layer intermittent suturing, which effectively approximates wound edges [17]. However, this method does not account for layered closure or tension distribution, which are crucial for optimizing wound healing. As a result, wounds closed with this technique may have excessive tension, uneven approximation, retained foreign material and an increased risk of postoperative scar hyperplasia [18]. In contrast, cosmetic suturing techniques emphasize precision and tension reduction at multiple anatomical levels. This approach *involves* gentle tissue handling, thorough wound cleansing, meticulous trimming and the careful selection of appropriate sutures. By ensuring accurate alignment of anatomical structures, and incorporating progressive tension reduction, cosmetic suturing facilitates tension-free closure of the skin surface, thereby improving both functional and aesthetic outcomes. In this study, pediatric patients with maxillofacial trauma were randomly assigned to one of two treatment groups. The intervention group underwent wound closure using cosmetic suturing techniques combined with polydioxanone sutures for subcutaneous tension reduction, while the control group received full-layer intermittent suturing with non-absorbable sutures. This study aimed to compare the efficacy of these two approaches in reducing postoperative scar formation and enhancing wound healing outcomes.

During the cosmetic suturing procedure, 5-0 and 6-0 polydioxanone sutures were used for precise subcutaneous alignment, with knots tied deeply to prevent suture irritation and

minimize any adverse effects on local blood circulation. The epidermis was closed using 7-0 silk thread with small needle and edge distances, ensuring a secure fit, the absence of needle scars, and an improved aesthetic outcome. At the 3-month and 6-month follow-up assessments, the intervention group demonstrated significantly lower VSS scores, indicating superior scar quality compared to the control group. Scar formation can be influenced by multiple factors. For instance, Wallace *et al*. [19] reported that, beyond basic cellular mechanisms such as cell division and proliferation, factors including the alignment of sutures with facial expression muscle movement patterns, the design of skin flap transfers, postoperative wound tension, and the presence of infection all contribute to scar development during cosmetic suturing. Similarly, Huang *et al*. [20] highlighted the efficacy of tension-reducing sutures in closing high-tension incisions and serve as an important basis for, emphasizing their role in minimizing scar formation.

Clinical studies have demonstrated that incisions subjected to high tension or located in areas with frequent movement are more likely to develop scar widening or hypertrophic scarring if appropriate tension reduction measures are not implemented. However, reducing local wound tension has been shown to partially inhibit scar hyperplasia and decrease the recurrence of pathological scars [21]. The role of sustained tension and variations in tension magnitude in the development of hypertrophic scars has been further substantiated through animal experiments conducted by researchers such as Li Qingfeng and JM Davidson [22, 23]. Their findings highlight the direct correlation between mechanical forces acting on the wound and the progression of scar formation. External skin tension reduction techniques *involve* the use of tension-relieving materials to pull the skin on both sides of the incision toward the incision line, thereby redistributing mechanical stress from the incision site to the surrounding skin. This method can be applied continuously wound healing process and the subsequent stages of scar maturation until scar stabilization occurs. By effectively alleviating local mechanical stress, external tension reduction not only facilitates wound healing but also significantly reduces the likelihood of excessive scar growth [24].

In this study, cosmetic suturing techniques combined with polydioxanone sutures were employed in the intervention group to achieve subcutaneous tension reduction, and follow-up assessments at 1, 3 and 6 months postoperatively revealed a gradual increase in scar width over time in both groups. However, the intervention group consistently exhibited narrower scars compared to the control group, with a statistically significant difference observed at the 6-month mark. The superior performance of polydioxanone sutures can be attributed to their unique properties, including prolonged tensile strength, excellent antibacterial characteristics and minimal tissue reactivity [25, 26]. These attributes enable sustained subcutaneous support, which plays a crucial role in improving postoperative scar quality, minimizing widening and enhancing aesthetic outcomes. Similarly, Gupta *et al*. [27] and Kia *et al*. [28] demonstrated that long-term subcutaneous reinforcement is an effective strategy for reducing scar expansion and promoting favorable wound healing, further supporting our results.

Post-traumatic wound management is often associated with complications such as short-term infection, bleeding and exudation, as well as long-term issues, including wound induration and suture reactions. However, in this study, both patient groups achieved primary wound healing without any of these complications. During the one-week and one-month follow-up periods, neither group exhibited signs of infection, bleeding, exudation, induration or suture-related reactions. Several factors contributed to these favorable outcomes. First, all patients underwent thorough wound debridement and strict aseptic procedures under general anesthesia, ensuring a clean surgical field and minimizing the risk of contamination. Second, the routine postoperative administration of oral antibiotics effectively prevented infections. Additionally, the use of polydioxanone sutures in both groups played a significant role in reducing complications. Polydioxanone sutures are associated with minimal tissue reactivity, and when tied deeply within the tissue, they prevent excessive knot tension and thread-related reactions. The findings of Gupta *et al*. [27] further support these observations, demonstrating that polydioxanone sutures induce a lower inflammatory response and remain in the skin for an extended period without exacerbating tissue reactivity [28]. Taken together, these factors, including surgical techniques, adherence to aseptic principles, postoperative antibiotic prophylaxis and the use of biocompatible suture materials, likely contributed to the absence of complications in both patient groups throughout the follow-up period.

A Cochrane review evaluating the use of subepidermal sutures for skin closure in non-obstetric surgeries reported that subcutaneous were associated with higher patient satisfaction. However, the study also found that subcutaneous suturing prolonged surgical time, and there was minimal with no substantial difference in surgical site infection rates compared to percutaneous sutures [29]. Similarly, Ashraf highlighted that subcutaneous sutures provide superior cosmetic outcomes and greater patient satisfaction than simple interrupted sutures [30]. In our study, we observed a significantly longer surgical time suturing compared to intermittent suturing. Despite this, the debridement and strict adherence to aseptic protocols ensured favorable healing outcomes in both groups. At the six-month follow-up, both groups demonstrated high satisfaction rates, with no statistically significant difference between them. These findings suggest that while cosmetic suturing may require additional operative time, it does not compromise healing outcomes or overall patient satisfaction.

Although the results of that study indicated that the use of polydioxanone sutures combined with cosmetic suturing for maxillofacial soft tissue wound closure in children could effectively reduce scar formation, several limitations had to be acknowledged. First, the sample size was relatively small (n = 104), which might have limited the statistical power of the findings. Second, the follow-up period was only six months, which might have been insufficient to fully assess the long-term evolution of scars. Therefore, future studies with larger sample sizes and longer follow-up durations were warranted to further validate the potential of polydioxanone sutures combined with cosmetic suturing in improving the aesthetic outcomes of maxillofacial trauma in children.

5. Conclusions

Optimal management of pediatric maxillofacial trauma requires meticulous wound debridement and strict adherence to aseptic protocols to promote effective healing and reduce the risk of complications. This study demonstrates that the integration of cosmetic suturing techniques with polydioxanone sutures provides sustained subcutaneous support, effectively reducing wound tension and minimizing excessive scar formation. By facilitating tension-free closure, this approach not only improves aesthetic outcomes but also enhances the overall quality of pediatric wound management.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

HH, XYX and YZ—designed the research study, reviewed and edited the paper. HH, WYW and QL—performed the research. SLX—analyzed the data. HH and XYX—wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was conducted at Wuxi Children's Hospital, Jiangsu Province, China, and was approved by the Ethics Committee of Wuxi Children's Hospital (WXCH2021-12-006). The registration number in the Chinese Clinical Registration Center was ChiCTR2400094703. The parents or guardians of all participants agreed to participate in the study.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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