Effectiveness of CO₂ Fractional Laser on Linear Scars in Children

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Background and Objectives

A facial laceration is a commonly occurring trauma of children. In addition, appropriate treatment and scar management are very important because the psychosocial impact of facial scars is much greater in children than in adults.

Materials and Methods

In the authors' hospital, primary closure was conducted targeting a total of 8,924 patients from January 2015 to December 2017. Of these, scar management was conducted on 808 people using a CO₂ fractional laser and Q-Switch Nd:YAG laser. To prove the effectiveness of the laser treatment on the linear scar, the patients were divided retrospectively into children and adults and sub-divided into those who received the treatment and those who did not. The subjective satisfaction of patients was evaluated using the Numeric Rating System (NRS). The objective scar scoring was evaluated using the image panel assessment based on the Vancouver Scar Scale (VSS), and the scoring was made by averaging the evaluations of three plastic surgeons.

Results

Evaluated NRS showed 8.50 ± 1.83 for adults without a laser, 8.51 ± 1.47 for adults with a laser, 7.93 ± 2.10 for children without a laser, and 8.9 ± 1.24 for children with a laser. The image panel assessment revealed 7.06 ± 1.31 for adults without a laser, 6.40 ± 2.37 for adults with a laser, 6.86 ± 1.45 for children without a laser, and 5.93 ± 1.21 for children with a laser.

Conclusion

When the linear scar is managed using a CO₂ Fractional laser, it can be managed in children better than adults, which is believed to be useful because it leads to better satisfaction and prognosis.

Key words

CO₂ laser; Sutures; Cicatrix; Pediatric

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INTRODUCTION

Facial wounds and scars inflict a serious psychosocial impact on the patient and this leads to significant emotional, social, and behavioral problems.¹ If this occurs at an early age, it can lead to more serious problems. Therefore, in the case of children, efforts to avoid scarring are more important.^{2,3}

Ever since the neodymium: yttrium-aluminum-garnet (Nd:YAG) laser at 1064 nm was found to inhibit collagen synthesis by Castro et al.⁴ in 1983, attempts to reduce scarring with laser have been tried in many ways. With nearly 30 years of effort, currently 585 nm Pulsed Dye Laser (PDL) is now known to be the most effective at reducing keloid and hypertrophic scars. It has also been reported that Fractional Carbon Dioxide (CO₂) Laser is effective in reducing scars.^{5,6}

The study does not have a large scale of the data about the patients over the age of 8. It is mostly focused on the children under the age of 8 whose parents have great concerns about the scars on their children. Therefore, this study was conducted by comparing these children with adults aged 20 and over either with or without laser procedures.

MATERIALS AND METHODS

After conducting a primary closure at our hospital from January 2015 to December 2017, the data were collected from the list of the patients being performed with scar management laser and their photographs taken at outpatient follow-up visit. After selecting the list of patients who underwent a primary closure treatment at our hospital, these patients were categorized into adult groups of over 20 years and children groups of under 8 years. Among each age group, the patients were also divided into two sub-groups who underwent laser procedures and those who did not. It means 2 age-different groups with 2 laser treatment and non-laser treatment groups in each. This makes 4 groups of the patients with suture care: one with laser treatment under age 8, the other without laser treatment under age 8; one with laser treatment over age 20, the other without laser treatment over age 20. The 30 patients were randomly extracted from each patient group using the Excel Rand function, and a total of 120 patients were randomly selected and the following telephone survey was conducted.

We assessed the list of patients with facial wounds who had had the suture care in our hospital from January, 2015 to December, 2017. All those patients were assigned

the 6-digit index numbers randomly via the Excel Random function. The patients with their index numbers were sorted in increasing order. The telephone survey had been conducted on the patients sorted in ascending order from December 1 to 31, 2018.

We asked the patients to send us the pictures which showed the condition of the recovered wounds at that time. We did not count any unresponsive patients: those who did not want to send us the pictures; those who did not pick up the phone; those who we had lost touch with.

We collected 30 patients with recent pictures for every group. Thus, there were 120 patients into 4 groups, each consisting of 30 patients.

There were 136 unresponsive patients out of 254 patients we tried to get hold of. We were also able to get pictures of 2 patients on their outpatient follow-up day (Table 1).

Patients were asked to evaluate the level of satisfaction on scars using the NRS scale (Numbered Rating Scale) of 0 to 10 points. In that case, the photos of scars were asked to be sent by email and messengers. Nonetheless, for some patients, their pictures were taken at the hospital.

It was not easy to have good cooperation with children during the laser procedure. However, under the condition that the anesthetic cream was applied properly to anesthetize the wound site, an immediate rapport with the children was developed by giving them goodies such as candy or chocolate. Indeed, it helped to save time for pediatric patients. In about 3-4 weeks after the total stitch out was conducted, CO₂ Fractional laser (DAESHIN, DS-40UB™) was applied three or four times at intervals of 3-4 weeks. In addition, when pigmentation was found, consequently a 1064 nm Q-Switch Nd:YAG Laser (SOODO Group, SHU C-9™) was used.

The length of the sutured wound on all patients was more than 3 cm. An ointment with onion extract ingredient and a silicone sheet were also prescribed and applied after total stitch-out.

For results, the photographs were randomly assigned to 3 experienced plastic surgeons and using the image panel assessment scale based on VSS (Vancouver scar scale), the evaluation was objectively made on 4 criteria of color, sheen, contour, and distortion having 14 points as the highest (severe scars), and the mean score was calculated and analyzed (Table 2).⁷

PASW 18.0 [SPSS Inc., Chicago, Illinois, USA] was used for statistical analysis. ONE-WAY ANOVA was used to measure the differences between the groups. Statistical significance was considered to be $p < 0.05$.

Table 1. Demographics

	AN	AY	CN	CY
Total	3,897 (35.97%)	358 (3.30%)	2,805 (25.9%)	221 (2.04%)
Accessed contact	64	61	63	66
Unanswered or Decline	27	25	24	27
No returned picture	7	6	9	11
Selected patients	30	30	30	30
Sex				
M	21	16	20	23
F	9	14	10	7
Average age	46.2	43.8	4.4	5.1
Sutured site				
Scalp	6	1	4	0
Forehead	5	11	11	10
Ocular	10	9	8	6
Cheek	2	2	0	4
Ear	4	0	3	0
Chin	3	0	3	5
Lip	0	2	1	2
Nose	0	5	0	3
Number of Laser		4.32		4.8
*Scar age (months)	31.45	31.4	28.64	25.36

AN, 20 years old or older patient without Laser treatment; AY, 20 years old or older patient with Laser treatment; CN, Less than 8 years old patient without Laser treatment; CY, Less than 8 years old patient without Laser treatment with Laser treatment; Total, number of patients who were sutured in our hospital during the period from 2015 to 2017(% of total); Scar age, The elapsed time period was evaluated from the date of sutured to the date of scar evaluated.

Table 2. Image panel assessment scoring table

Color	Perfect (1) Slight mismatch (2) Obvious mismatch (3) Gross mismatch (4)
Sheen	Matte (1) Shiny (2)
Contour	Flush with surrounding skin (1) Slightly proud/indented (2) Hypertrophic (3) Keloid (4)
Distortion	None (1) Mild (2) Moderate (3) Severe (4)

RESULTS

In our hospital, for 3 years from 2015 to 2017, primary closure had been conducted for 8,924 patients in emergency rooms and wards, and of these, 3,026 (33.9% of the total) were children under the age of 8. Considering that the number of children younger than age 8 accounted for 8.34% of the total population in the 2017 demographics, the primary closure on the children under age 8 wound occurs with high probability. Of the total 8,924 patients,

808 patients received Fractional CO₂ laser treatments on outpatient follow-up visits, and of these, 221 (27.35%) patients were younger than 8 years of age.

Nd:YAG Laser was additionally applied to 62 of them afterwards as it was needed. Nevertheless, the 120 patients in this study were selected randomly. Those who underwent the additional Nd:YAG Laser treatments were not included for the study.

The average number of sessions on the patients with laser scar treatment was approximately 4.58 sessions: 4.32 sessions for the age of over 20; 4.8 sessions for the age of under 8. When evaluating the level of patient's overall satisfaction on scars using NRS (0 points - dissatisfied, 10 points - satisfied), the results have shown 8.50 ± 1.83 for adults without laser, 8.51 ± 1.47 for adults with laser, 7.93 ± 2.10 for children without laser, and 8.90 ± 1.24 for children with laser (Fig. 1). The values of each of these groups were verified using the ONE-WAY ANOVA test.

When the mean scores of the groups were compared by ONE-WAY ANOVA test for statistical significance, the *p*-value was 0.179. Since *p*-value is not within 0.05, there is no statistically significant difference in the means of the groups.

As a matter of fact, the differences in the mean values on the groups via Image Panel Assessment Scale is sta-

tistically significant. The assessment was based on VSS evaluation criterion of 14 points for severe scars and 4 points for fair scars without a trace. The mean VSS scores are 7.06 ± 1.31 for adults without laser, 6.40 ± 2.37 for adults with laser, 6.86 ± 1.45 for children without laser, and 5.93 ± 1.21 for children with laser (Fig. 2).

As a result of the one-way ANOVA test on the mean VSS scores, the p -value is 0.042 ($p < 0.05$).

The differences of the mean satisfaction scores by a patient or one of the patient's parents are not statistically significant. As for the mean score of image panel assessment scale by the well experienced clinicians, the statistically significant differences exist between the means of independent groups on our study (Table 3). In other words, the children with scars under age 8 have a better result with laser scar care. For instance, there was a

Fig. 1. NRS differences between the groups. Standard deviation is stated with a solid line.

Fig. 2. Image panel assessment score differences between the groups. Standard deviation is stated with a solid line.

Table 3. Result

	AN	AY	CN	CY	<i>p</i>
Satisfaction (10)	8.50 ± 1.83	8.51 ± 1.47	7.93 ± 2.10	8.90 ± 1.24	0.179
Scar score (14)	7.06 ± 1.31	6.40 ± 2.37	6.86 ± 1.45	5.93 ± 1.21	0.042

Statistically significant ($p < 0.05$).

Fig. 3. A 3-year-old patient with forehead linear scar due to the laceration. (A) Front picture of forehead before the 1st laser treatment (42 days after the suture). (B) Before the 2nd laser treatment (3 months after the suture). (C) Before the 3rd laser treatment (4 months after the suture). (D) After 15 months after the suture.

3-year-old boy who had had 4 sessions of the laser treatment, and the mean score of Image Panel Assessment Scale reviewed by 3 plastic surgeons on his scar was 4.3 which was relatively a very high score (Fig. 3).

DISCUSSION

According to the analysis on the paper published through the 2011 meta-analysis, in the case of the pulsed dye laser (PDL) 585nm, currently, many studies have proved its effectiveness and the author was recommending the PDL 585nm as the first choice for scar management. In addition, although more data needs to be accumulated for the effectiveness of PDL 595, fractional nonablative laser 1,540 nm, CO₂ laser 10,600 nm, Nd:YAG laser 532 nm, and Erbium:YAG laser 2,940 nm, it is known to be effective in scar treatment.⁸

There was a case report that a 1064-nm Q-switched Nd:YAG laser treatment on the aberrant Mongolian spot with an excellent result. However, the laser studies on children have not yet been performed actively.⁹

Here, the significance can be found in that the study has proven the usefulness of CO₂ Fractional laser on the simple laceration of children: it has greater effectiveness to the children than the adult patients.

In fact, studies on scars are actively carried out but there are still a lot of unknowns. However, the process of scar formation is related to the immune response and the children have fewer scars than adults as children's immune system is not as well developed as adults.¹⁰ For this reason, even for burn scar, it has been reported that a topical silicone gel and pressure garment therapy also has a better VSS score for children than adults.¹¹

In addition, when considering the psychosocial impact of scars on one's life, it is important that more delicate scar management is needed for children than adults. Although this study was designed and surveyed by computer-based randomized selection, there were some limitations. The number of patients was relatively small. The term of study was relatively short. There were selection biases in the study. The selection biases would include the severity of a laceration wound & the gender ratio of patients, et cetera. Depending on the severity of a laceration wound, the result of the study would be different.

Moreover, the groups with and without laser treatments were not randomly selected since the patients were arbitrarily given laser procedures according to their insurance or economic conditions. In collecting data, a telephone survey was used by untrained interviewers on a specific target population. The pictures & information

were gathered from the respondents who had different camera equipments or cell phones with different skills. The unresponsive patients were totally excluded. These may lead to a serious selection bias especially for VSS score.

It has been statistically analyzed from the groups of randomly selected patients via our well organized laser center. The study proposes that the laser used in children provides satisfaction to the patients with better results on a scar treatment than adult patients.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest to disclose.

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