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ARTICLE

# Autologous fat transplantation for the treatment of abdominal wall scar adhesions after cesarean section

Sheng-Hong Li[a]*, Yin-Di Wu[a]*, Yan-Yun Wu[a], Xuan Liao[a], Pik-Nga Cheung[a], Ting Wan[b], Li-Ling Xiao[a], Jian-Xing Song[c], Hai-Ling Huang[a] and Hong-Wei Liu[a]

[a]Department of Plastic Surgery, The First Affiliated Hospital, Jinan University, Key Laboratory of Regenerative Medicine, Ministry of Education, Institute for New Technologies of Plastic Surgery of Jinan University, Guangzhou, China; [b]Department of Obstetrics and Gynecology, Guangzhou Women and Children's Medical Center, Guangzhou, China; [c]Department of Plastic Surgery, Changhai Hospital, The Second Military Medical University, Shanghai, China

**ABSTRACT**

Cesarean section results in scarring, which usually leads to adhesion between the subcutaneous fat and the abdominal wall muscle. The present study aimed to evaluate the therapeutic effect of autologous fat grafting on scar adhesion to the abdominal wall after cesarean section. Thirty-six patients with scar adhesion to the abdominal wall after cesarean section were recruited and treated between October 2013 and December 2015. The adhesion between the subcutaneous fat and the abdominal wall muscle was carefully separated through a small incision in the original scar to form multiple subcutaneous tunnels. Aspirated fat was injected into the scar lesion and subcutaneous tunnels, and the wound was then sutured. The clinical outcome was evaluated by comparing the pretreatment and 1-year posttreatment photographs and Patient and Observer Scar Assessment Scale (POSAS) scores. All patients had a marked improvement in the appearance, texture, and depression of the scar during 12 months of follow-up. The 1-year posttreatment POSAS scores for the color, pain, pruritus, hardness, fullness, mobility, and appearance of the scar were significantly decreased compared with the pretreatment scores. Hematoxylin-eosin staining revealed adipocyte-like cells in treated scar tissue specimens obtained 1 year after treatment. None of the patients reported severe adverse reactions. Autologous fat grafting combined with adhesion release may be a good treatment option for abdominal wall scarring after cesarean section. This method is minimally invasive and effective in achieving good functional and esthetic outcomes.

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**LEVEL OF EVIDENCE**
Level VI; therapeutic study

## Introduction

According to the National Health and Family Planning Commission as well as the Center for Disease Control and Prevention of the People's Republic of China, the average cesarean section rate in China is 46%, which is the highest in the world [1]. Cesarean section results in a surgical wound that usually forms scar adhesions and even hypertrophic or keloid scars. Postoperative cicatricial adhesion negatively affects the appearance of the healed surgical wound, causes pruritus, and usually requires treatment [2,3]. Numerous methods have been proposed for the treatment of scars, but none of them are satisfactory. Thus, the treatment of cesarean section scarring remains a challenge.

The treatment options for cesarean section scarring include surgical and nonsurgical methods. Nonsurgical treatments include pressure therapy, topical drug injection, radiotherapy, and laser therapy [4], which partially improve the appearance and pruritus but not the depression caused by surgical scars. Surgical treatment is also widely used and involves cutting the scar along the original incision and releasing the adhesion between the subcutaneous fat and the muscle of the abdominal wall. However, these scar treatments result in a very high incidence of re-adhesion and new scar formation [5]. Thus, different treatment methods are needed to improve the therapeutic effect [6].

Autologous fat grafting is often employed to treat body contour defects. Currently, the increased interest in the regenerative properties of fat grafting is due to the discovery of mesenchymal stem cells stored in harvested fat. These adipose-derived stem cells (ADSCs) have remarkable regenerative potential and the ability to restore damaged tissue [7–10]. Studies have shown that ADSCs have angiogenic and antifibrotic properties that affect wound healing, soft tissue restoration, and scar remodeling and thus may play a role in managing scar adhesion [11–13]. However, this role is not clearly described in the literature. Thus, the present study was designed to describe the surgical method

CONTACT Hong-Wei Liu liuhongwei0521@hotmail.com Department of Plastic Surgery, The First Affiliated Hospital, Jinan University, Key Laboratory of Regenerative Medicine, Ministry of Education, Institute for New Technologies Plastic Surgery of Jinan University, No. 613 West Huangpu Avenue, Guangzhou 510630, China
*The first two authors contributed equally to this work.
Supplemental data for this article can be accessed here.

in detail and to evaluate the effectiveness of autologous fat transplantation combined with the release of scar adhesion in treating the depression and adhesion caused by cesarean section scarring.

## Materials and methods

### Patient information

The study cohort comprised 36 patients aged 22–38 years (mean age 33 ± 1.5 years) who underwent cesarean section and sought surgical treatment for abdominal scarring. The scar had been present for more than 1 year in all included patients and was accompanied by pain, pruritus, and an unappealing appearance. The included patients had strip-shaped abdominal scars and obvious adhesion that affected the appearance of the abdominal wall. The scars were classified as depressed, linear, and hypertrophic. Scar release and fat transplantation were performed at the Department of Plastic Surgery, the First Affiliated Hospital of Jinan University. All patients provided informed consent.

### Surgical procedures

#### Cesarean section scar adhesion release

The patient was in the supine position. Local anesthesia was administered using 0.25% lidocaine mixed with 1:100,000 epinephrine. A small surgical incision (≤0.5 cm) was created on the original scar. The tissue adhesion under the scar was carefully isolated with a small hook knife or a knife shaped like a spade (Figure 1) to form multiple subcutaneous tunnels, and the subcutaneous adhered tissue was completely released (Video 1).

### Autologous fat harvest

Approval for autologous fat harvesting and transplantation was obtained from the Institutional Review Board of Medical Science, Jinan University, and written consent was obtained from the study participants. The liposuction sites were located in the lower abdomen, thigh, and knee. The incision for lower abdominal liposuction was made at the inner edge of the umbilicus. Lidocaine (0.125%) was used as a topical infiltrating anesthetic. A no. 11 scalpel was used to make an incision of approximately 3 mm in accordance with the preoperative plan. A no. 20 blunt-side-opening long needle was used to inject the tumescent anesthesia solution (25 ml of 2% lidocaine + 2 mg of adrenaline + 12.5 ml of 8.4% sodium bicarbonate + 1000 ml of normal saline). The amount of tumescent fluid injected depended on the amount of fat required and the range of liposuction. A side-opening liposuction needle with an inner diameter of 3 mm was inserted into the subcutaneous fat layer, a 20 ml syringe was connected, and subcutaneous fat was extracted using the syringe liposuction technique [14,15]. Uniform radioactivity extraction was conducted, and the amount of extracted fat depended on the amount of fat required to fill the subcutaneous tunnels of the scar. The contused tissue around the incision was trimmed, and the skin incision was sutured. The surgical area was bandaged under pressure. The collected fat was statically precipitated and filtered to remove the tumescent anesthetic fluid and was then placed in a 10 ml syringe for use.

### Fat transplantation

Fat injection was performed in the operating room. The purified fat was placed into a 1 ml syringe and injected through a cannula with a 2 mm inner diameter into the cicatricial lesions, the isolated subcutaneous tunnels, and around the deep adhered tissues. The transplanted autologous fat filled the gap between the original adhered tissues as an isolating layer, and the wound was carefully sutured. The amount of transplanted fat varied based on the condition of the abdominal wall scar in each patient. Most of the patients in the present cohort needed a second fat transplantation procedure, and those with marked scar depressions needed even a third fat transplantation procedure.

### Adjunctive treatment

The light-emitting diode (LED) red light source was the LED system from Wuhan Med Science Technologies (Wuhan, China). This treatment device emits visible red light (633 ± 10 nm) at a power density of 280 W/m$^2$ at room temperature and a distance of 20–25 cm from the target surface. The treated area received red light irradiation for 20 min twice a day (Figure 2). The treatment began 1 day after the fat transplantation procedure and was scheduled to continue for 1 week.

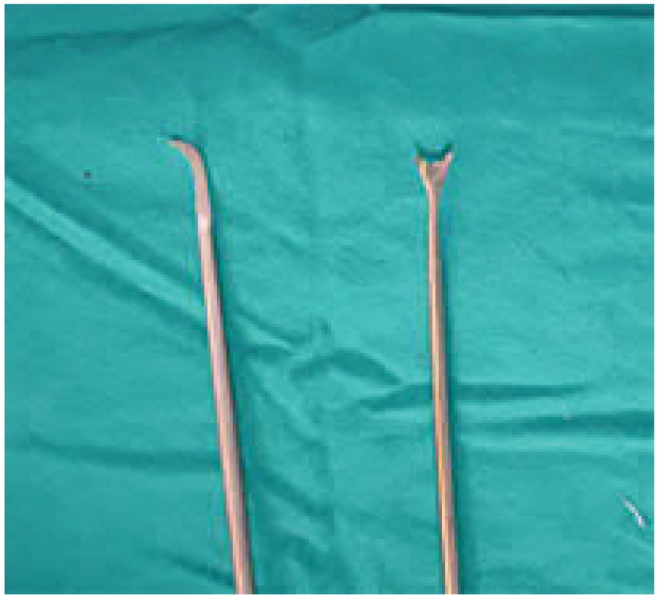

Figure 1. Photograph of the small hook knife (left) and spatula knife (right) used to release the scar adhesions to the abdominal wall after cesarean section.

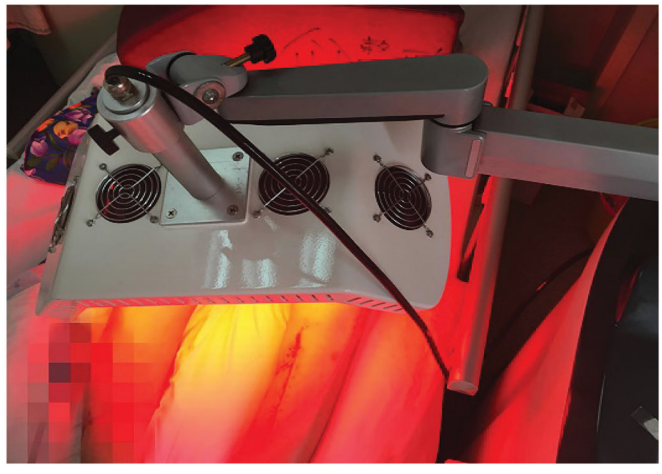

Figure 2. Irradiation of the affected area with an LED red light source.

### Assessment methods

A thorough preoperative assessment was performed on all patients to confirm that the scar had been present for more than 1 year and that no other treatment had been performed. A digital camera (Canon, EOS 70D, Tokyo, Japan) was used to take pretreatment photographs and 1-year posttreatment photographs of the treated area.

Scars were assessed before the treatment and at 1 year after the treatment by the patient and surgeons in accordance with the Patient and Observer Scar Assessment Scale (POSAS) criteria [16] (Table 1). Sixteen patients were excluded; the reasons for exclusion were the administration of additional treatments such as drugs and laser therapy during the 1-year follow-up period ($n = 8$), pregnancy ($n = 2$), and incomplete information ($n = 6$). Therefore, the data from 20 patients were analyzed to assess the treatment efficacy.

### Hematoxylin–eosin staining

When the patients underwent a second fat transplantation at 1 year after the initial fat transplantation, a sample of scar tissue from the surgical area was collected from six randomly selected patients. The specimens were embedded in paraffin, sectioned, and stained with hematoxylin-eosin (HE) before being observed using an optical microscope (Olympus, Tokyo, Japan).

### Statistical methods

The POSAS values were statistically analyzed using the Wilcoxon rank-sum test. A $p$ value of less than 0.05 was considered to indicate statistical significance. A $p$ value of less than 0.01 was considered to indicate a large degree of statistical significance.

Table 1. The questionnaire administered before autologous fat transplantation and at 1 year after fat transplantation.

| | (Normal) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | (Worst) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Color | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | |
| Pain | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | |
| Itching | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | |
| Hardnes | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | |
| Fullness | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | |
| Mobility | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | |
| Appearance | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | |

## Results

### Clinical outcomes after fat transplantation

Thirty-six patients received both scar adhesion release and fat transplantation in the abdominal wall and were monitored for 12 months. No clinically significant complications, infections, fat cysts, granulomas, or other unwanted adverse effects were observed. At 1 year after treatment, the scar color, skin texture, and tissue mobility were significantly improved, and the scar depression had become flat (Figures 3–5).

### POSAS assessment

The patient- and surgeon-rated POSAS scores for the color, pain, pruritus, hardness, fullness, and shape of the scar were significantly lower at 1 year after treatment than before treatment (Table 2).

### Histological evaluation

At 1 year after fat transplantation, adipocyte-like cells were observed in the treated scar tissue (Figure 6). Inflammatory cells and blood vessels were present around the transplanted fat in the treated scar tissue.

## Discussion

The incision scar after cesarean section is a common type of abdominal wall scar that usually leads to tissue adhesion around the surgical incision; this adhesion affects the appearance and mobility of the skin. The treatment of such scars requires both volume restoration and texture improvement. Existing evidence suggests that autologous fat grafting may be a novel method for the repair of tissue damage [17].

Grafted fat is a unique regenerative filler with soluble factors and progenitor cells that may be useful in remodeling scar tissue. The fat grafting technique has been enhanced to achieve long-


Figure 3. Gross appearance of the abdominal wall scar before and 1 year after autologous fat transplantation. A marked improvement in the appearance of the abdominal wall scar was observed 1 year after treatment.

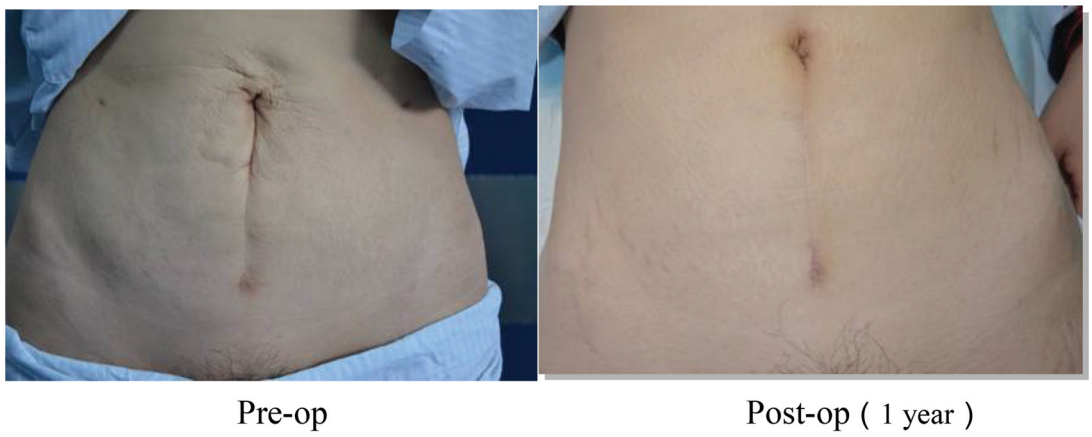


**Figure 4.** Gross appearance of the abdominal wall scar before and 1 year after autologous fat transplantation. A marked improvement in the depression of the abdominal wall scar was observed 1 year after treatment.

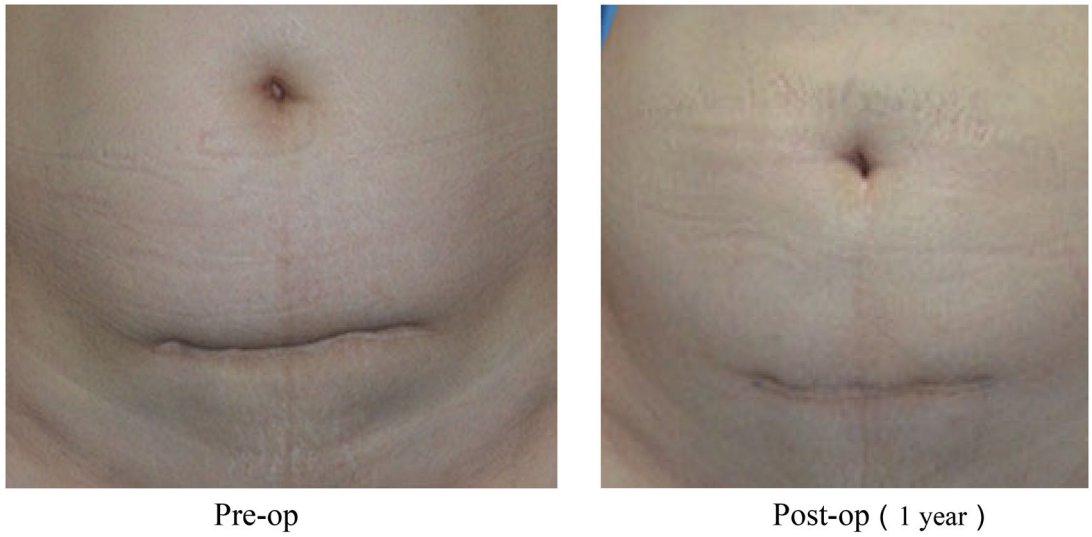


**Figure 5.** Gross appearance of the abdominal wall scar before and 1 year after autologous fat transplantation. A marked improvement in the adhesion of the scar to the abdominal wall was observed 1 year after treatment.

**Table 2.** POSAS values of the scar tissue before autologous fat transplantation and at 1 year after fat transplantation.

| | Mean (before surgery) | Mean (after 1 year of surgery) | *p* values |
|---|---|---|---|
| Color | 6.3 | 4.2 | <0.01 |
| Pain | 3.1 | 2.5 | <0.01 |
| Itching | 4.5 | 2.7 | <0.01 |
| Hardness | 7.6 | 3.5 | <0.01 |
| Fullness | 6.4 | 4.2 | <0.01 |
| Mobility | 6.0 | 3.7 | <0.05 |
| Appearance | 4.1 | 2.6 | <0.01 |

term survival of the transplanted fat and volume retention of the recipient area [18]. Accumulating evidence shows that transplanted fat not only restores the volume of the recipient area but also promotes local tissue regeneration, causing improvements in the texture of aging skin and scars as well as accelerated wound healing of radiation-damaged tissue and chronic ulcers [19]. The underlying mechanism is still not completely understood. With the further investigation of stem cells, regenerative medicine technology has become a new and rapidly developing subject that is implemented in clinical treatment.

Autologous fat grafts are made up of fat cells, extracellular matrix, and ADSCs. As ADSCs have been shown to play a role in antiaging and skin regeneration, the scar-remodeling effect of fat grafts may be related to ADSCs; this hypothesis is supported by the findings of a previous study that evaluated the intracranial injection of ADSCs in hypertrophic scars in rabbit ears [20]. Furthermore, fat harvesting is technically easy and minimally invasive. Thus, autologous fat might be an ideal material for the treatment of deep scar tissue adhesion [21]. In the present study, a small incision of less than 5 mm was created in the original scar site to release the scar adhesion to the abdominal wall and inject the fat graft. This technique reduces the possibility of the formation of new scars due to incisions during treatment. Fat was transplanted between the subcutaneous tissue and the abdominal wall muscle to prevent the recurrence of scar adhesion. The texture of the skin in the scarred region was significantly improved after autologous fat transplantation.

The fat grafting technique is commonly used to treat scar tissue formed due to burns, radiation, and cytostatic damage [22]. Autologous fat may represent an anti-adherence compound that prevents scarring. However, the exact mechanism by which fat transplantation improves scar texture and adhesion remains

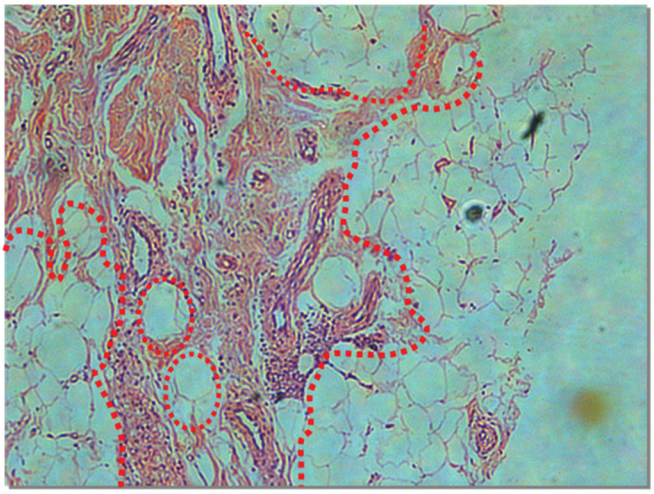

Figure 6. HE staining of a sample from the treated scar tissue collected at 1 year after fat grafting (original magnification, ×40). The adipocyte-like cells (indicated by the red dotted line) are irregular and nearly circular. Inflammatory cells and blood vessels are present around the transplanted fat in the scar tissue.

unclear. Fat injection may improve scar formation by promoting scar remodeling *via* the introduction of mesenchymal cells and growth factors contained in the lipoaspirate [23]. Klinger et al. reported that transplanted fat survived in scar tissue and not only stimulated the regeneration of dermal tissue but also increased the subcutaneous tissue content, the thickness of the dermis in scar tissue and the softness of the skin [24]. Transplanted fat forms new collagen deposits during wound repair and reconstruction and increases the degree of local tissue vascularization [25]. Therefore, autologous fat transplantation improves the appearance and function of scars to restore scar tissue as close as possible to normal skin and provides new directions for the study and treatment of scars. Mojallal et al. demonstrated that fat transplantation improves the synthesis of collagen fibers at the transplantation site, which significantly improves the quality of the skin [26].

In the present study, there were many adipocytes in the treated scar tissue, suggesting that the survival of fat cells after transplantation may be the mechanism for the prevention of adhesion recurrence. The surviving fat cells themselves improve the thickness, flexibility, and mobility of scars; soften the scars; and significantly improve the texture of the skin in the treated area. Our findings provide new evidence that the injection of processed autologous fat may be a promising and effective therapeutic approach for the treatment of scar adhesion.

## Conclusion

Autologous fat grafting significantly reduced adhesion recurrence, filled the scar depression, and improved the skin texture in the treated area. This technique is a good option for the treatment of abdominal wall scar adhesion after cesarean section and represents a minimally invasive and effective scar treatment that achieves good functional and esthetic outcomes.

## Ethical approval

This research protocol was approved by the Ethics Committee for Research of the First Affiliated Hospital of Jinan University.

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## Disclosure statement

The authors declare that they have no conflicts of interest.

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