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Autologous Fat Grafting for Mixed-Type Atrophic Acne Scars: A Case Report in Female

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Abstract

Background: Acne scars are a clinically prevalent and psychologically significant sequela of acne vulgaris, affecting up to 95% of patients and associated with reduced quality of life, social withdrawal, and diminished self-esteem. Despite decades of research, evidence for fat grafting in mixed-type atrophic acne scars remains limited to small case series.
Objective: This case report aims to evaluate the short-term clinical outcomes of autologous fat grafting in a 37-year-old female with Goodman and Baron Grade IV mixed-type atrophic acne scars.
Methods: This case study identified a 37-year-old female with atrophic acne scars. The tumescent technique was utilized to harvest fat from her abdomen, which was processed into microfat and nanofat using the *Lipocube® NanoKit-5* and then injected subcutaneously and applied topically to the patient's face. The efficacy of the procedures was assessed during different follow-up visits, with an emphasis on scar reduction and dermal regeneration.
Results: A significant reduction in edema was clinically observed on Day 4 post-procedure. As this was a single case with a 4-day observation period, no statistical analysis was performed. Descriptive assessment tools were used at baseline and will be repeated at scheduled follow-up visits.
Conclusion: Autologous fat transfer using microfat and nanofat is a promising preliminary therapy for atrophic acne scars. It provides cosmetic improvement with low morbidity. However, longer-term evaluation is needed to establish its efficacy. Future studies with larger cohorts and standardized multi-timepoint assessments are warranted to establish the role of this technique in standard dermatological practice.

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INTRODUCTION

Acne vulgaris is a histologically chronic inflammatory disease of the pilosebaceous follicle that manifests as comedones, erythematous papules, pustules, and nodular/cystic lesions. This disease most commonly affects the face, neck, chest, and back (Say et al., 2021). In Indonesia, *acne vulgaris* accounts for approximately 80–100% of dermatological cases and ranks as the third most frequent reason for outpatient visits to Dermatology and Venereology departments (Sinaga, 2020). The condition is not limited to adolescents; it persists in 26% of women and 12% of men in their fourth decade of life, with atrophic scarring developing in up to 95% of affected individuals.

Acne vulgaris is a chronic inflammatory disease of the pilosebaceous follicle presenting as comedones, papules, pustules, and nodulocystic lesions. When severe inflammatory lesions

remain untreated, they cause irreversible dermal destruction, resulting in permanent atrophic scarring—the primary clinical focus of this case report. The condition most commonly affects the face, neck, chest, and back (Say et al., 2021).

Atrophic acne scars result from the permanent loss of dermal collagen and subcutaneous adipose tissue following deep inflammatory acne. Histologically, scar depression reflects disrupted collagen architecture and volume deficiency. Three main subtypes are recognized: ice pick scars (approximately 60–70% of cases; narrow and deep), boxcar scars (20–30%; broad with sharp vertical edges), and rolling scars (15–25%; undulating, wide-based scars with subcutaneous tethering) (Zaleski-Larsen et al., 2016).

The pathogenesis of *acne vulgaris* and the subsequent formation of acne scars are interconnected. The development of *acne vulgaris* occurs in two stages. In the non-inflammatory phase, lesions such as open and closed comedones are present with minimal inflammation; therefore, scar tissue is generally not formed. As non-inflammatory lesions progress to inflammatory lesions such as nodules, cysts, or pustules, extensive inflammation occurs in the deeper regions of the dermis, resulting in scar formation if left untreated. The most important determinants of post-inflammatory sequelae involved in acne scarring are the severity, extent, depth, and intensity of inflammation, as well as the subsequent tissue repair cascade following inflammatory injury.

The transition from non-inflammatory comedones to inflammatory nodules and cysts triggers neutrophil and macrophage activation, releasing pro-inflammatory cytokines (IL-1β, TNF-α) and matrix metalloproteinases (MMPs) that degrade dermal collagen types I and III. When MMP activity exceeds tissue inhibitor of metalloproteinase (TIMP) regulation, a net collagen deficit results, forming the structural basis of atrophic scarring. Measurable outcome variables in this study include scar grade (Goodman and Baron scale), scar morphology (ice pick, boxcar, and rolling scar distribution), pore size (mm), skin elasticity (%), and sebum/moisture parameters (*A-One Smart Analyzer*).

A number of treatments have been proposed for acne scarring. Both inflammatory and non-inflammatory lesions may be treated with topical retinoids, which act on multiple stages of acne development by preventing new comedones, reducing existing lesions, and targeting inflammation. These agents are effective as monotherapy and may also serve as adjunctive therapy. The addition of benzoyl peroxide to antibiotic therapy reduces bacterial resistance. Oral isotretinoin is indicated for the treatment of severe acne. Although many topical and systemic treatment options are available, achieving significant clinical improvement in acne scars remains challenging. Common acne scar treatments include physical approaches (e.g., laser therapy, intense pulsed light, and cryotherapy), surgical approaches (e.g., dermabrasion and subcision), and topical medications.

However, these methods frequently produce variable or unsatisfactory results, and no gold-standard treatment for these lesions has been established. A recent review of scientific evidence from the past three decades regarding autologous fat grafting classified this modality as a multifaceted agent for tissue repair because numerous studies demonstrated its ability to improve skin structure, regeneration, and rejuvenation. However, despite their widespread use, these modalities have significant limitations: laser resurfacing carries a substantial risk of post-inflammatory hyperpigmentation in Fitzpatrick skin types III–VI, requires multiple sessions, and fails to restore lost dermal volume; surgical subcision corrects fibrotic tethering but does not replace lost tissue; and topical agents show minimal efficacy for established scarring. No single gold-standard therapy exists for mixed-type atrophic scars, particularly those requiring simultaneous volume restoration and dermal regeneration (Behrangi et al., 2022).

Autologous fat grafting has attracted particular interest as a technique for restoring volume and improving skin quality. Adipose tissue is obtained via liposuction and processed to separate adipocytes and stromal vascular fraction cells. The stromal vascular fraction is a heterogeneous population of cells, including adipose-derived stem cells, endothelial cells, vascular smooth muscle cells, and immune cells. Adipocytes play a restorative role in maintaining volume and correcting contour irregularities, whereas endothelial and vascular smooth muscle cells promote neovascularization. Adipose-derived stem cells modulate immune responses,

stimulate angiogenesis, degrade excess extracellular matrix, and undergo adipogenesis. Thus, fat grafting may positively influence skin changes associated with acne scars.

The use of biocompatible autologous grafts has provided successful options for soft-tissue augmentation and volume replacement with relatively minimal morbidity. Fat transfer is considered one of the promising treatment options for atrophic acne scars. In this case report, we demonstrate the use of microfat and nanofat transfer to treat atrophic acne scars, thereby contributing to a better understanding of the procedure and its therapeutic potential. The benefits of fat transfer therapy make it a reasonable alternative treatment option for acne scars.

A study by Behrangi (2022) reviewed existing modalities such as laser therapy, subcision, and topical treatments, concluding that although these approaches can improve skin texture, they often fail to restore dermal volume and require multiple sessions with variable outcomes. Regenerative potential of autologous fat grafting, particularly because of the presence of adipose-derived stem cells that promote angiogenesis and collagen remodeling; however, the study noted a lack of standardized clinical protocols and objective evaluation methods for reporting treatment outcomes. These findings indicate that although regenerative approaches are promising, there remains a gap in clinically documented and standardized applications integrating both volumetric restoration and measurable skin improvement.

This case report aims to document the clinical application and early outcomes of standardized autologous fat grafting (microfat + nanofat, Lipocube® NanoKit-5) in a 37-year-old female patient with Goodman and Baron Grade IV mixed-type atrophic acne scars, assessed using validated dermatological grading and digital skin analysis.

METHOD

This is a descriptive single-patient case report conducted at the Dermatology and Venereology Polyclinic, Sanglah General Hospital, Denpasar, Bali, Indonesia, in accordance with CARE (CAse REport) reporting guidelines. Written informed consent was obtained from the patient for clinical management, photography, and publication of de-identified clinical data. Ethical approval was obtained from the relevant Institutional Review Board.

The Dermatology and Venereology Polyclinic is a work unit of Sanglah General Hospital in Denpasar. A 37-year-old Balinese woman (referred to as RM 01233587), an Indonesian citizen, presented for her first consultation on May 8, 2023, with the chief complaint of acne scars. The patient visited the cosmetic division of the clinic with complaints of facial acne scars that had persisted for the past four years and were prominent on close examination. She stated that acne had first appeared on her face eight years earlier as a result of stress related to her activities and menstruation. It initially presented as small papules that gradually enlarged and frequently contained pus. The patient presented with painful, pruritic acne, which had been treated by a dermatologist and venereologist for five years. Although the acne had subsided, visible scars remained. These scars caused the patient concern and insecurity, leading her to seek treatment from multiple physicians. She reported a habit of squeezing and scratching the acne lesions but denied any subsequent itching or pain associated with the scars. There was no history of drug allergies.

The inclusion criteria included the following: (1) the patient reported no history of abnormal scar tissue formation or excessive scar growth after injury. There was no personal history of systemic illnesses, such as hypertension, diabetes mellitus, or asthma, and no history of prolonged or spontaneous bleeding episodes. (2) The patient reported using morning and evening creams prescribed by a beauty clinic, which she was still using but stated had not improved her condition. She also reported never having undergone treatments such as chemical peels or laser therapy. (3) The patient is a nurse and does not smoke or consume alcohol. She also stated that her father had similar complaints.

On general physical examination, the patient was in fair condition, fully conscious, with a blood pressure of 110/70 mmHg, pulse rate of 80 beats per minute, and axillary temperature of 36.0°C. The head was normocephalic, with no alopecia. Examination of the eyes revealed no anemia or jaundice. Examination of the ears, nose, and throat was unremarkable. Oral examination showed no abnormalities of the mouth or oral mucosa. On cardiac examination, there was a regular heart rhythm with no murmurs. Lung examination revealed vesicular breath sounds without rhonchi or wheezing. The abdomen was soft and non-tender, with no

hepatosplenomegaly and normal bowel sounds. The upper and lower extremities were warm, without edema, and the nails appeared normal. There was no enlargement of regional lymph nodes.

Cutaneous examination of the patient's face revealed numerous atrophic scars of varying morphologies, including boxcar, rolling, and ice pick scars, with oval-to-geographic shapes measuring approximately 0.3 × 0.5 × 0.3 cm to 0.4 × 1 × 0.6 cm. The patient had Fitzpatrick skin type IV (Figure 1). Scar evaluation using the Goodman and Baron Qualitative Global Acne Scarring Grading System demonstrated Grade IV scarring, defined as severe atrophic or hypertrophic scars that are readily visible at a social distance greater than 50 cm and cannot be adequately concealed with makeup or facial hair. These scars also do not flatten when the surrounding skin is stretched.

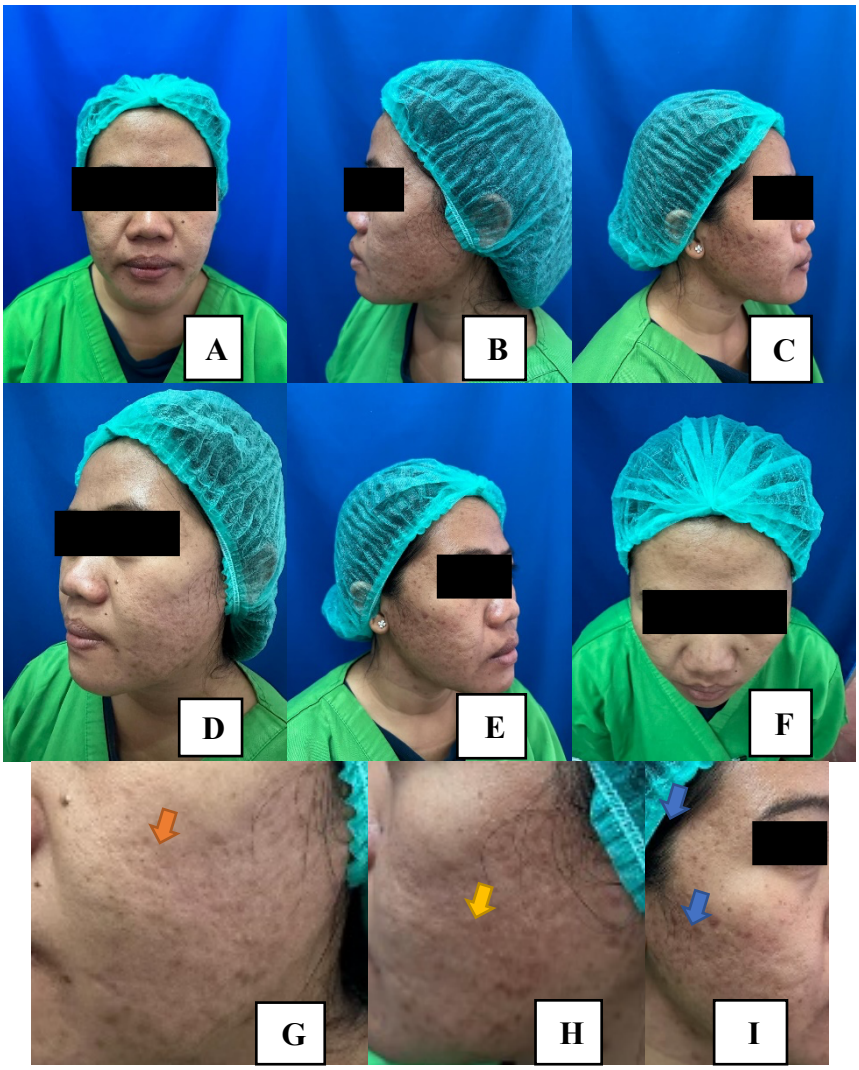

Figure 1. Before fat transfer on frontal view (A), sisi lateral (B, C), sagittal side 45^{the} (D, E) and the superior side(F). Froze showing atrophic scar type of left cheek enlarged part boxcar (G, orange arrow) and typerolling (H, yellow arrow), right cheek atrophic scar typeice pick (I, blue arrow).

Dermoscopic examination showed brown yellow central plug (Figure 2).

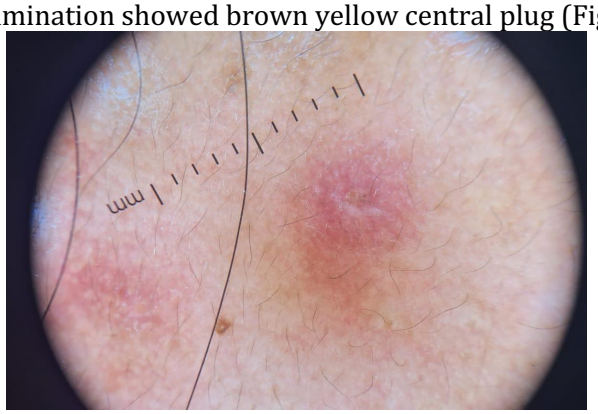

Figure 2. Dermoscopic image shows the presence of brown yellow central plug.

Complete blood count (April 14, 2023) results showed hemoglobin 12.8 g/dl (12.0-16.0); hematocrit 38.80% (36.0-46.0); platelets: 368.00 10^3/µL (140-440); leukocytes 6.51 10^3/µL (4.1-11.0); neutrophils 4.07 10^3/µL (2.50-7.50); lymphocytes 1.98 10^3/µL (1.00-4.00); monocytes 0.39 10^3/µL (0.10-1.20); eosinophils 0.05 10^3/µL (0.00-0.50); basophils 0.02 10^3/µL (0,01-0,1), RBC 4,48 10^6/µL (4.0-5.2), red cell distribution width (RDW) 13.70% (11.6-14.8), MCH 28.60 pg (26.0-34.0), MCV 86.60 fL (80.0-100.0), PPT 10.3 seconds (10 – 12.7), INR 0.9 (0.9-1.1), and APTT 29.2 seconds (23-34.7).

The patient has been scheduled to have the procedure of autologous fat transfer to correct atrophic lesions on the face, with adipose tissue harvested from the abdomen and transplanted to replace it as microfat and nanofat. LP 5 is used to micro and nanofat processed. We explained in detail the reason, side effects, complications, expected results of fat transfer and possibility of fat resorption at 1-2 weeks after surgery. Not only does the fat transfer serve to stimulate volume in the atrophic lesions, but also it is thought to provide a skin rejuvenating effect when applied topically. With patient consent, a fat transfer was performed and a facial analysis with the Bomtech® A-One Smart Skin Analysis. The A-One test showed wide pores with a mean size of (0.23) mm and (13.19%) For wrinkles, the results showed mild effects and pigmentation was found normal. High U-zone sebum grade normal T-zone sebaceous grade. The moisture dimension showed regular outcomes; however the elasticity was minimal. Figure 3A-D demonstrates markings that were made prior to the fat transfer procedure on the abdomen for a site of fat harvesting and on the face identifying an area for fat grafting. Preparations for the tumescent anesthesia, Lipocube® NanoKit-5 fat transfer kits and equipment used to harvest the fat were also made.

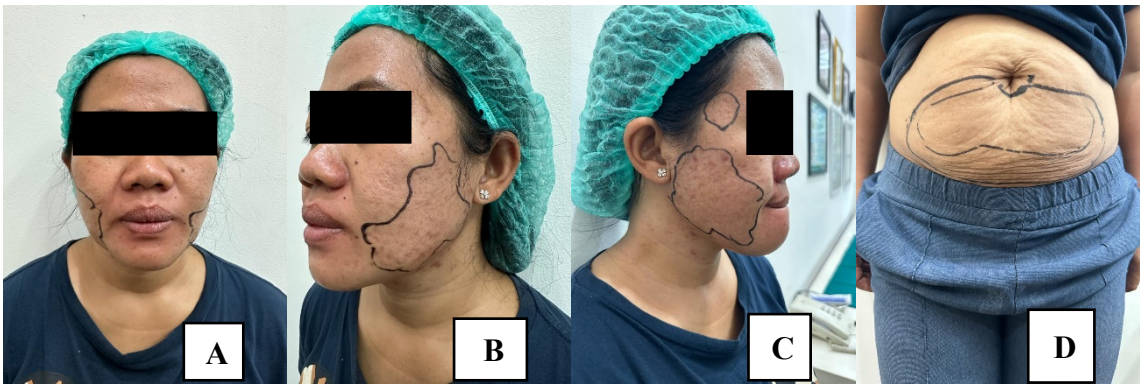

Figure 3. Marking the site of fat transfer and harvesting(A-D). Fig. 1: Mark of atopic scars on the right and left sides of facial skin (A-C). (D) Marking on the suitable upper abdomen area for fat harvesting

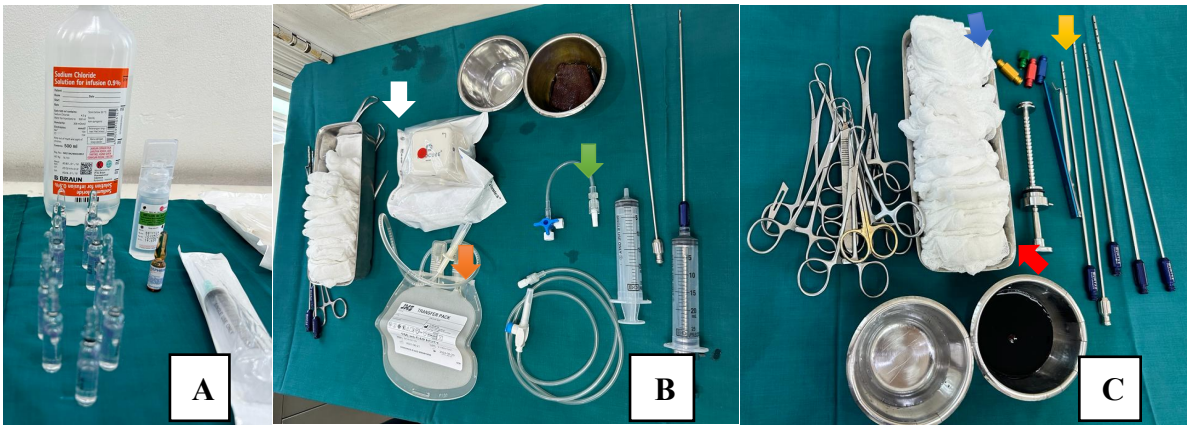

Figure 4. Tools for preparing tumescent anesthesia include 0.9% NaCl solution, sodium bicarbonate solution, lidocaine, epinephrine (A). Humanistic StructureTool fat transferLipocube® NanoKit-5 NanoKit-5 contains 20 ml luer lock syringe (green arrow), lipocube and lipobag with threeway valves as well as infusion set (orange arrow) (B). Tool fat harvesting including cannula (yellow arrow) and fat syringe vacuum aspirator (red arrow) luer lock-to-luer lock transfer with a 1.2 mm; 1.4 mm; and 2.4 mm diameter (blue arrow) (C).

After preparing the patient and Lipocube® NanoKit-5 device, the donor site of fat harvesting is prepared: sterile abdomen by povidone iodine. After that, anesthecia was given at the site of cannula insertion; incision to perform the cannulal insertion and tumescent anesthesia (fig 5A-D) was performed. Tumescent anesthesia consisted of 12.5 ampoules (25 ml) of lidocaine diluted in up to 500 ml, of 0.9% NaCl plus epinephrine half an ampoule (1 mg/ml) and sodium bicarbonate (6.5 ml). The solution was administered visually under the guidance of a vacuum aspirator machine which has settings for tissue infiltration with fluid. In the end, the anesthesia was applied throughout all marked abdominal areas until more hyperpigmented and tumes areas were appeared. Forty-five minutes of tumescent anesthesia was followed by fat harvesting.

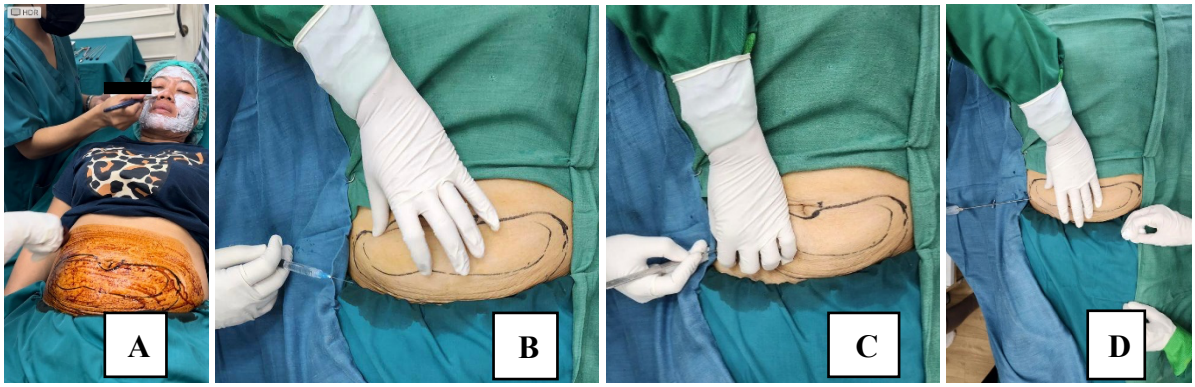

Figure 5. Harvesting of the fat and field for anesthesia. A: The field is being sterilized with povidone inodine. Lidocaine anesthesia at the cannula insertion point (B). Incision to subcutaneous tissue 3 mm (C). Cannula insertion and subcutaneous infiltration of tumescent anesthesia (D).

Fat harvesting was performed with a Tonnard harvester cannula inserted and negative pressure applied to the syringe (fat syringe vacuum aspirator). Under negative pressure, the lipoaspirate was naturally drawn into the syringe. After lipoaspirate filled the syringe, it was transferred to lipobag (figure 6A-C). 135 ml of lipoaspirate was collected and the lipofat was separated from blood and tumescent fluid The lipobag was raised 30 minutes to allow the blood and anesthetic solution to flow by gravity to the bottom of the lipobag. Subsequently, 65 ml of blood and tumescent fluid were discarded, resulting in a final lipoaspirate consisting of 70 ml of pure fat (Figure 6D-F).

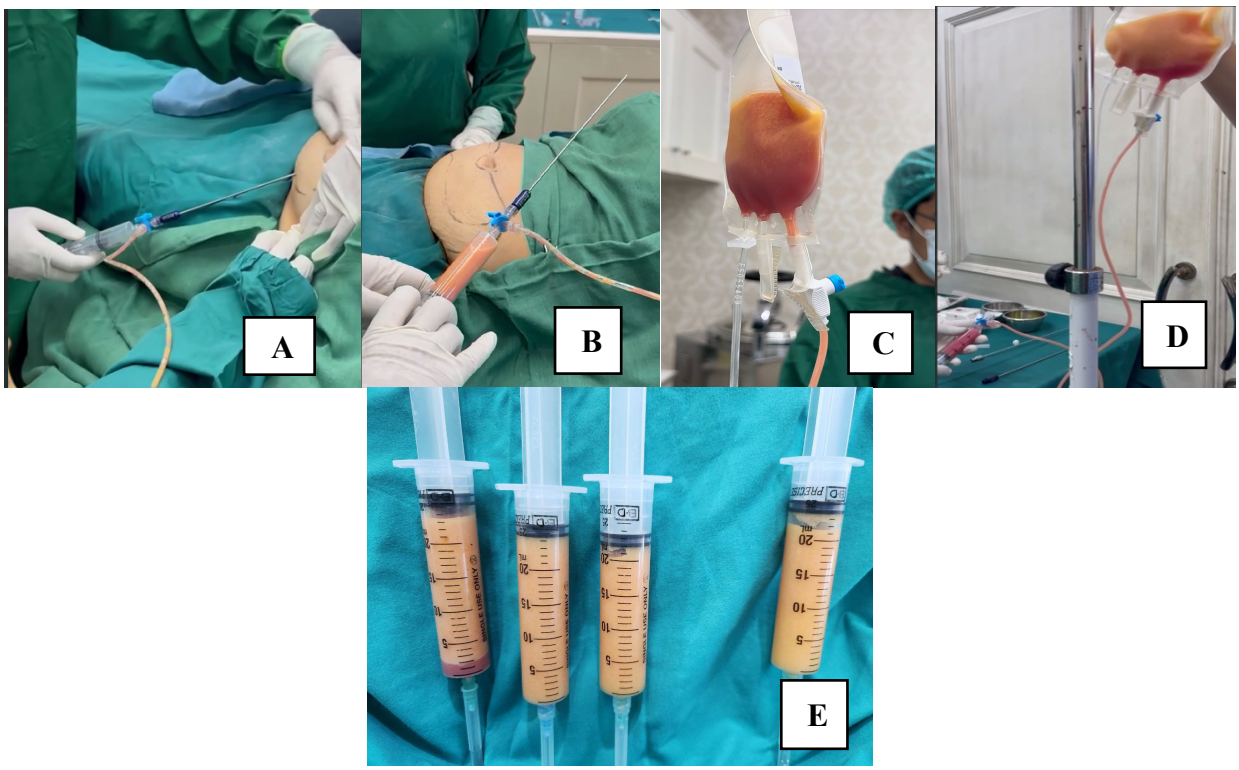

Figure 6. Fat harvesting process. The cannula is introduced into the fatty tissue and the negative pressure from the syringe aspirates the lipoaspirate (A). Lipoaspirate transfer from syringes to lipobag (B). Lipoaspirate is a mixed gas of adipocyte cells, blood and anesthetic fluid (C). Partial withdrawal of lipoaspirate containing blood and anesthetic fluid (discarded) (D). The step after this, yellowish lipoaspirate retrieved in a 20 ml syringe and separated for purification process.

The process of purifying millifat into nanofat using a filter on a lipocube device. Purification begins with filtration of millifat into microfat, microfat into emulsified microfat, and emulsified microfat into nanofat (Figure 7A-C).

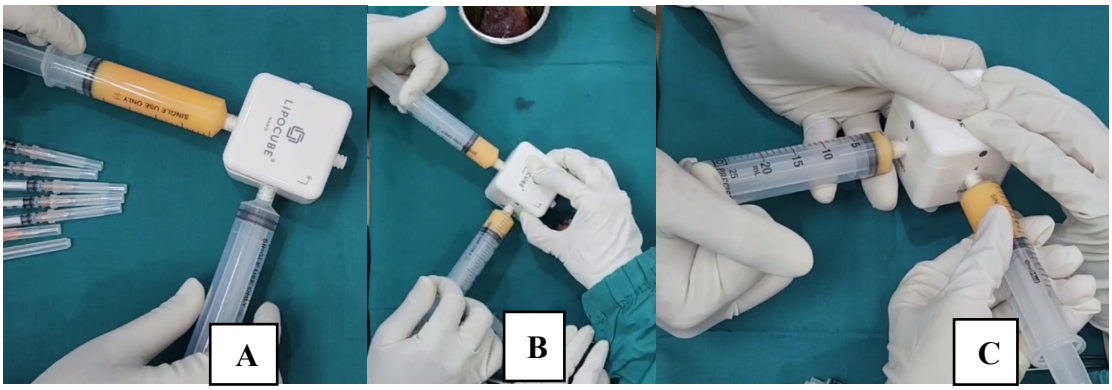

Figure 7. Lipoaspirate purification process. Lipoaspirate milliphate is filtered to microphate (A). Microfat lipoaspirate was emulsified by filtration 10 times on nanocubes (B). Filtration of emulsified microfat into nanofat through a 500 micron filter (C).

In the first stage, milifat is purified into microfat using a filtration method by inserting milifat into hole number 1, and an empty 20 ml syringe into hole number 2 to obtain microfat with a more yellowish color than milifats. Next, the Lipocube filtration cap is rotated clockwise (45 degrees) between position 1 and 2 (positions 2-3) creating emulsified microfat. Microfat obtained from hole number 2 is kept, an empty 20 ml syringe is placed in hole number three. The 10 passes of microfat pushed through the filter, create an emulsified product that appears much more yellow

than preemulsification. The last step is to keep the emulsified microfat from hole number 3, rotate clockwise (45 degrees) the Lipocube filtration cap and place an empty 20 ml syringe in hole number 4. After this, the emulsified microfat is pushed out to make nanofat from the empty 20 ml syringe with an average filter size of 500 microns. However, only 4 ml of nanofat was obtained during the last filtration owing to resistance. 4 ml of nanofat and 5 ml of microfat were extracted from the last step, which was transferred to a 1 ml syringe during this process.

Next comes the injection of microfat and nanofat at the location of atrophic lesions and the topical application on patient's face. 2.5% lidocaine + 2.5% prilocaine topical anesthesia is coated over the entire face for 30 min. The patient's face is then cleaned, and the needle insertion sites are sterilized. Local anesthesia via subcutaneous lidocaine at the point of access. A 20G needle is inserted to create the entry point, followed by subcision performed with blunt-tipped 25G cannula in the atrophic region for breaking down the connective tissue bonds and creating spacing in the fibrotic area (Figure 8A-B). Once surgery is completed, subcutaneous microfat injection (above muscle plane) in the atrophic area of the left maxilla with a blunt-tipped 25G cannula until symmetry achieved. Microfat and nanofat of the right maxillary area were injected until it looked thicker (Fig. 8C–E) for compensating resorption in the future. This way, a total of 0.5 ml nanofat is placed onto all facial surface (Figure 8F). The total volume of microfat and nanofat that was injected in the right maxillary region was 2 ml and 1 ml respectively; while only 0.5 ml of nanofat was injected into the right temporal region. Two milliliters of nanofat were injected in the left maxillary area (Figure 8G).

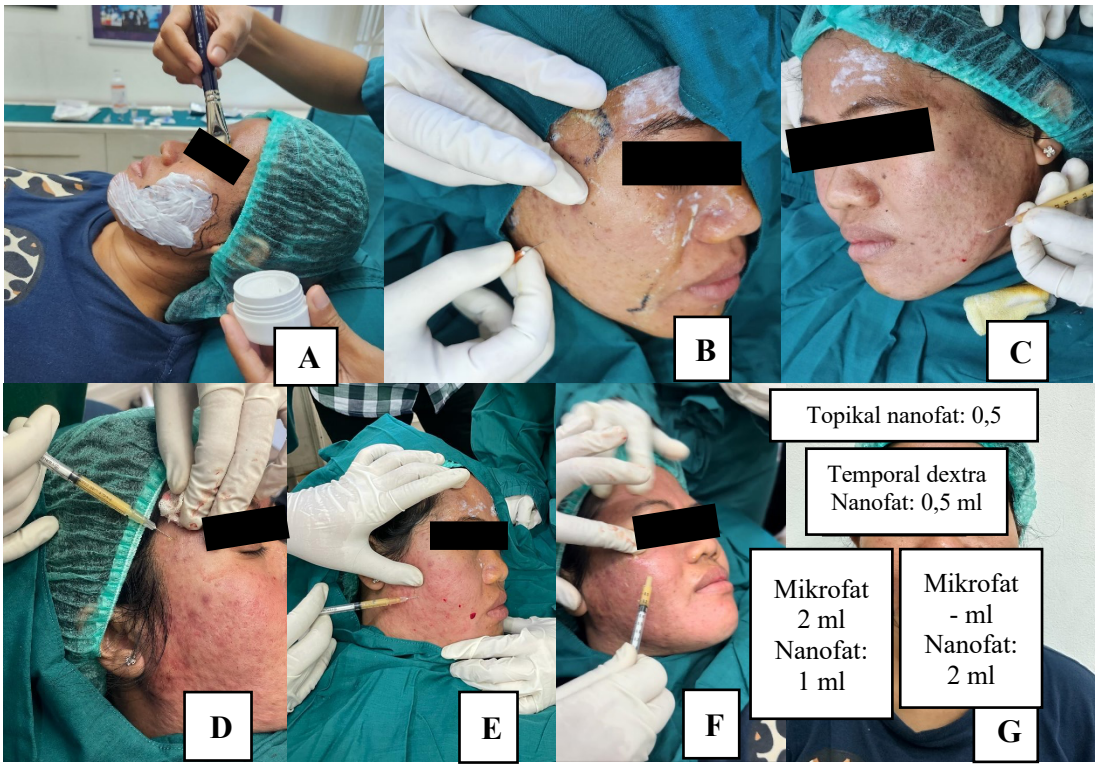

Figure 8. The procedure of face fat transfer. Facial topical anesthesia, needle puncture site anesthesia(A). Entry point using 20G needle(B). Inserting a 26G blunt-tipped cannula with combined subcision techniques and subcutaneous (above muscle) microfat and nanofat injections (C-E). Topical nanofat application all over the face(F) Distribution of microfat and nanofat volume (G).

Follow-up Observation I (Post Fat Transfer Procedure)

Patients also reported no pain after fat harvesting and fat transfer (feeling the abdomen shirt thick). Injection of microfat and nanofat were performed with an insufficiency of pain in the facial region.

On the physical examination, the general condition was good; the patient was fully conscious, with blood pressure of 120/80 mmHg, a heart rate of 90 bpm and axillary temperature at 36.7ºC; normocephalic head without alopecia. There was no anemia or jaundice on eye examination. There were no abnormalities on examination of the ears, nose and throat. The oral cavity and mucosa were unremarkable. Cardiac exam revealed a single, regular heart sound without murmurs and lung exam showed normal vesicular breath sounds without rhonchi or wheezing. Physical examination of the abdomen was positive for normal bowel sounds with no liver or spleen enlargement. There was warmth of both upper and lower extremities without edema, and age appropriate capillary refill. There was no enlargement of regional lymph nodes. Dermatologicaly, the patient presented with multiple atrophic scars of several types (boxcar, rolling and ice pick type) with an oval-geographic shape measuring between 0.3x0. 5x0. 3 cm to 0.4x1x0. 6 cm, with reddish skin and edema. The Fitzpatrick skin type of the patient was IV (Figure 9A-D).

Cefadroxil 500 mg orally every 12 hours for 5 days, mefenamic acid 500 mg orally every 8 hours (for pain, as needed), and gentamicin 0.3% ointment topically every 12 hours to the lesion were prescribed. The patient was further counseled on the empirical application of cold compresses to the bruised area and was asked to wear a stomach bandage for 1 month after treatment; return visits were arranged at 1 day, 1 week, 3 weeks, as well as 3 months and 6 months post-procedure for evaluation.

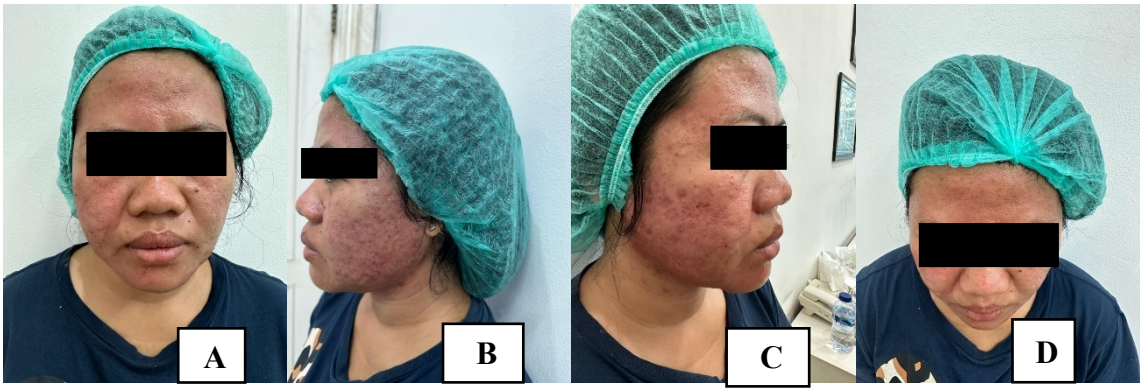

Figure 9. Clinical picture after fat transfer. Skin with reddish and edematous appearance. Frontal side(A), sides lateral(B, C) and the superior side(D).

Follow-up Observation II (day 4, May 12, 2023)

In the follow-up observation 4 days post fat transfer. The patient stated that the lesions on the face had improved after the procedure but still looked swollen in places. The patient denied having pain and redness. The patient was said to have begun complaining of pain in the area around her stomach following the liposuction procedure, but those complaints were said to be tapering off.

On examination, the patient was conscious, stable and comfortable; blood pressure 120/80 mmHg; pulse rate,80 beats per minute; axillary temperature of 36.0ºC: Normocephalic head with no hair loss noted. No evidence of anaemia or jaundice on examination of the eyes. In the ears, nose or mouth, there were no abnormalities with both the oral and buccal mucosa appearing normal. Cardiac examination showed a single, regular heart sound without murmurs; the lung auscultation revealed normal vesicular breath sounds without rhonchi or wheezing. Examination of the abdomen revealed normal bowel sounds, no hepatomegaly or splenomegaly. Upper and lower extremities warm without edema; nails within normal limits. No enlargement of regional lymph nodes.

Dermatological examination revealed multiple boxcar, rolling and ice pick atrophic scars over the face along with oval-geographic shape ranging from 0.3x0. 5x0. 3 cm to 0.4x1x0. 6 cm, with improved redness and reduced edema. The Fitzpatrick skin type for the patient was IV (Figure 10 A-D). The A-One analysis showed an average pore size of 0.23 mm and a percentage of 13.19% (Fig. 5). Wrinkles were subtle, and pigmentation was normal. The sebaceous levels were very high in the U-zone but normal on the T-zone. Moisture was normal, however elasticity was

extremely low. Previous treatment including cefadroxil and gentamicin cream was stopped. She was also advised to return in 1 week for a follow-up visit for evaluation of any issues following fat transfer.

Figure 10. The clinical picture of the evaluation 4 days after fat transfer. The red skin seems to have begun improving and the edema has resolved. Frontal wall (A), side regarding (B,C), as well as the superior side (D).

RESULTS AND DISCUSSION

Results

Acne vulgaris is a chronic inflammatory skin disease that affects the pilosebaceous follicles and appears as comedones, papules, pustules, nodules, and cysts. The face, neck, chest, and back are the most affected areas. The major pathophysiological events leading to acne vulgaris are increased proliferation of Cutibacterium acnes within the follicles, sebaceous gland hyperplasia causing seborrhea, abnormal shedding of the epithelium of the sebaceous follicle (comedogenesis), and subsequent inflammatory and immunological reactions (Say et al., 2021). According to Sinaga (2020), the prevalence of acne vulgaris in Indonesia was reported to be between 80% and 100%, ranking third among visits to Dermatology and Venereology departments in hospitals and clinics.

This case demonstrates mixed-type atrophic acne scarring in a 37-year-old Fitzpatrick skin type IV female, consistent with published data showing acne vulgaris prevalence of 80%–100% in Indonesia and acne scar development in up to 95% of affected patients (Sinaga, 2020). Extended epidemiological background has already been provided in the Introduction and is therefore not repeated here. This discussion focuses on the interpretation of clinical findings.

Discussion

Acne scars occur because of severe inflammation affecting the dermis, although they may also be caused by aggressive manipulation of acne lesions by the patient. Therefore, the treatment of acne scars is mainly motivated by the significant psychological effects and decline in quality of life experienced by patients with acne vulgaris (Wasitaatmadja et al., 2015).

A scar is an area in which normal skin tissue has been replaced by fibrous tissue following disease or trauma (Soliman et al., 2018). This represents a normal wound-healing cascade. Healing is categorized into regeneration and repair. Regeneration stimulates mitosis of damaged cells to heal without scarring, whereas repair occurs in the dermis when normal tissue is replaced with fibrous tissue to maintain skin integrity (Powers et al., 2016). Unlike hypertrophic scars, which form because of excess tissue deposition, acne scars are atrophic in nature, characterized by tissue loss or indentation. The most common acne scars are atrophic scars that induce skin indentation (Fabbrocini et al., 2010).

Atrophic acne scars are the consequence of injury to adipose tissue and collagen and clinically present as various types of skin depressions. Histological analysis reveals that the loss

of fat and collagen causes these depressions (Zaleski-Larsen et al., 2016). Atrophic scars can be further classified as ice pick, boxcar, or rolling scars, with approximately 60%–70% of atrophic acne scars being ice pick scars, followed by boxcar scars (20%–30%) and rolling scars (15%–25%). Ice pick scars have V-shaped extensions extending into the dermis, whereas boxcar and rolling scars are shallower and have a wide base (Goodarzi et al., 2020).

The concurrent presence of boxcar, rolling, and ice pick scars in this patient reflects multifocal inflammatory damage involving both the superficial reticular dermis (boxcar scars) and deep dermis with subcutaneous tethering (rolling scars), as well as complete follicular necrosis extending to the subcutaneous level (ice pick scars). This morphological complexity, corresponding to Grade IV severity, validates the selection of a combined microfat (structural volumization) plus nanofat (regenerative stromal vascular fraction [SVF]) approach rather than single-modality treatment.

The patient was a 37-year-old woman who had been troubled by post-acne scars for four years. A mixed-type pattern of scarring (rolling, boxcar, and ice pick scars) characterized the atrophic scarring observed in this patient. Although the acne itself had improved, the patient felt that the scars significantly affected her appearance and reduced her self-confidence.

Many factors influence the development and progression of acne. The key factors include excessive keratinization of sebaceous glands, increased sebum production during puberty, and the presence of anaerobic bacteria such as Cutibacterium acnes in sebaceous gland areas, resulting in inflammatory conditions of varying severity. Other important factors include genetic predisposition, immune response, hormonal changes, stress, and poor diet (Adamski et al., 2021).

Acne vulgaris is a common skin disease closely associated with the pathogenesis of acne scarring. Acne vulgaris is characterized by two sequential stages: the non-inflammatory stage, involving the formation of comedones with minimal inflammation and therefore minimal risk of scarring and the inflammatory stage (Cong et al., 2019). Deep and extensive inflammation affects the dermis when non-inflammatory lesions progress into inflammatory lesions such as nodules, cysts, or pustules. Eventually, scar tissue develops if these lesions are not adequately treated. Acne scar severity is directly proportional to the area, depth, and intensity of inflammation, and the repair process depends on the degree of inflammatory reaction (Taylor et al., 2011).

A comparative study revealed significant differences in the histopathological and immunohistochemical features between acne lesions that scar and those that do not. The authors noted a prominent immune response among subjects prone to scarring, initially weak and ineffective but progressively increasing as the body attempted healing (Brodell et al., 2013). Non-scarring lesions, however, demonstrated an early pronounced but nonspecific inflammatory response that resolved rapidly during healing. Hence, early control of inflammation is important to prevent or limit the risk of acne scars (Dreno et al., 2015).

Before discussing acne scars, it is important to understand the wound-healing cascade. In human physiology, wound healing is divided into three phases: inflammatory, proliferative, and maturation (or remodeling) phases (Gonzalez et al., 2016). These phases may overlap. The inflammatory phase, lasting from 24 hours to two weeks, is marked by erythema. During this stage, platelets, neutrophils, and macrophages produce cytokines such as transforming growth factor-beta (TGF-β), platelet-derived growth factor (PDGF), and vascular endothelial growth factor (VEGF). During the proliferative phase, cell migration, proliferation, re-epithelialization, angiogenesis, and fibroplasia occur.

Epidermal repair begins with migration of keratinocytes to cover the damaged area and restore tissue integrity, a process taking approximately 24–48 hours. Dermal activity begins three to four days after injury and is characterized by granulation tissue formation, angiogenesis, and fibroblastic proliferation. Fibroblasts produce collagen, proteoglycans, fibronectin, and elastin, which are the building blocks of the extracellular matrix. Basic fibroblast growth factor (bFGF), epidermal growth factor (EGF), keratinocyte growth factor (KGF), TGF-α, and TGF-β are key cytokines involved in this phase (Dulmovits & Herman, 2012). Collagen is synthesized and deposited over the subsequent two to four weeks, followed by remodeling beginning approximately 21 days after trauma. During this phase, collagen fibers undergo degradation and reorientation. Matrix metalloproteinases (MMPs) degrade collagen, whereas tissue inhibitors of metalloproteinases (TIMPs) help regulate tissue breakdown. A low MMP/TIMP ratio may result in atrophic scarring, whereas high levels may lead to hypertrophic scar formation. This stage may

last from several months to years (Bainbridge, 2013).

The pathophysiology of acne scarring is determined by the severity and depth of inflammation. In acne vulgaris, inflammation occurs beneath the epidermis, particularly within dermal tissue in the infrainfundibulum of the pilosebaceous unit (Prasad, 2016). Deep inflammatory injury can result in atrophic scars because inflammatory mediators and enzymatic activity in the dermis promote tissue destruction and subsequent scarring (Tan et al., 2017). Acne scars are classified according to color, depth, contour, and surface texture. Macular scars involve only the epidermis and superficial dermis and develop after inflammation as erythema or hyperpigmentation.

Inflammatory mediators induce melanogenesis, and these scars may persist for long periods, particularly in patients with darker skin tones. Ice pick scars arise from deep dermal inflammation resulting in complete follicular necrosis and tissue loss and are characteristically narrow and deeply penetrating the dermis or subcutaneous tissue. Rolling scars are caused by inflammation involving hair follicles extending into the subcutis and sweat glands. Attachment of the epidermis and dermis to the subcutaneous tissue creates broad and deep scars. Boxcar scars are round, oval, or irregular depressions with sharply demarcated edges and may range from superficial to deep (Moon et al., 2019).

Goodman and Baron proposed a qualitative acne scar grading system (Goodman and Baron Qualitative Global Scarring Grading System) based on four levels of severity (Goodman & Baron, 2006). Grade 1 (macular) includes scars that are hyperpigmented or hypopigmented and erythematous but visible only on close inspection. Grade 2 (mild) includes mild atrophic or hypertrophic scars not visible from 50 cm or more and easily concealed with makeup or beard shadow if located outside the face. Grade 3 (moderate) includes atrophic or hypertrophic scars visible from 50 cm or more that cannot be easily concealed with makeup or beard shadow in men but may flatten when the skin is stretched. Grade 4 (severe) includes severe atrophic or hypertrophic scars that are clearly visible from more than 50 cm away, cannot be easily concealed with makeup, beard shadow, or hair if located outside the face, and cannot be flattened by stretching the skin (Goodman & Baron, 2006).

In this case, according to the qualitative acne scar grading system, the patient was classified as Grade 4 (severe), as the scars were clearly visible from a distance greater than 50 cm, could not be concealed with makeup, and did not flatten when the skin was stretched.

Several approaches have been used to treat acne scars. Acne therapies target inflammatory and non-inflammatory lesions by preventing comedone formation and reducing existing lesions through modulation of inflammation. Topical and oral antibiotics are effective as monotherapy but are more effective when combined with topical retinoids. Benzoyl peroxide reduces the risk of antibiotic resistance. Oral isotretinoin is approved for the treatment of severe acne. Numerous topical and systemic therapies are available; however, complications may still arise, and acne scars remain a therapeutic challenge. Acne scar treatments primarily involve physical modalities (such as lasers, intense pulsed light, and cryotherapy), surgical modalities (e.g., dermabrasion and subcision), or topical agents. Nevertheless, many of these techniques remain inconclusive and unsatisfactory, and no gold standard has yet been established for management of these lesions. In recent years, autologous fat grafting has emerged as a significant approach for full-thickness tissue repair, with studies demonstrating its efficacy in skin structural restoration, regeneration, and rejuvenation (Behrangi et al., 2022).

Fat grafting offers many advantages, including abundant availability, ease of access, good biocompatibility, and minimal surgical trauma. Although fat grafting was initially used only for soft-tissue filling during defect repair and deformity correction, current evidence suggests multilineage differentiation potential of stromal vascular fraction (SVF) cells and adipose-derived stem cells (ADSCs) present in transplanted fat. Under certain conditions, these cells can differentiate into adipocytes, osteocytes, chondrocytes, and neural cells and can also secrete cytokines such as tumor necrosis factor, VEGF, hematopoietic growth factor, and bFGF, which promote survival of transplanted fat.

Grafting can be performed using macrofat, microfat, or nanofat. (1) Macrofat is obtained from fat grafts larger than 2.4 mm and is mainly used to fill large areas such as the breasts and

buttocks, usually injected using blunt cannulas 2 mm or greater in diameter. (2) Microfat is harvested using cannulas with hole diameters of 1.2–2.4 mm and emulsified through a 1.2 mm emulsifier; microfat is used for finer anatomical areas such as the forehead, eyelids, eyebrows, nose, and hands. (3) Nanofat is harvested using cannulas ranging from 1.2 to 2.4 mm, with emulsifier sizes of 400–600 μm; nanofat demonstrates greater efficacy for superficial wrinkles. Macrofat is mainly used to achieve larger volume augmentation and preserve viable adipocytes in procedures such as breast reconstruction. Nanofat injections are often performed during the same procedure as microfat injections. Microfat serves a structural volumizing role, whereas nanofat generally improves overlying skin quality and promotes tissue regeneration, making it useful for scar treatment, chronic wounds, and facial aesthetic procedures (Shih et al., 2020).

Nanofat was initially described by Tonnard et al. in 2013. The process involves removal of particulate fat to produce an oily emulsion followed by filtration to obtain SVF gel enriched with ADSCs. Researchers have continued refining Tonnard's technique for nanofat production. Although mature adipocytes are destroyed during this process, many mesenchymal stem cells (MSCs) remain viable. These MSCs can proliferate, differentiate, and function through paracrine signaling, which is considered the essential mechanism underlying nanofat therapy. Nanofat, containing relatively high concentrations of stromal vascular fraction (SVF) and adipose-derived stem cells (ADSCs), can induce neovascularization and tissue regeneration through paracrine activity and differentiation into adipocytes, thereby improving fat graft survival while facilitating tissue repair and regeneration (Behrangi et al., 2022).

Because of its optimal biocompatibility, autologous fat grafting (AFG) offers inherent advantages over other fillers for soft-tissue augmentation and volume restoration with lower patient morbidity (Shih et al., 2020; Xie et al., 2020). AFG has demonstrated positive aesthetic effects related to volume restoration and reduction of skin wrinkles, including when applied to patients with scleroderma (Gheisari et al., 2018; Strong et al., 2015). Liposuction harvesting of adipose tissue is used to obtain both adipocytes and stromal vascular fraction (SVF) cells, which are subsequently processed. SVF is a heterogeneous population containing adipose-derived stem cells, endothelial cells, vascular smooth muscle cells, and immune cells.

Adipocytes help correct contour irregularities and promote angiogenesis through stimulation of endothelial and vascular smooth muscle cells following AFG. Mature adipocytes are also known to regulate immune functions, stimulate angiogenesis, reduce excessive extracellular matrix deposition, and facilitate adipogenesis. Consequently, AFG may theoretically improve cutaneous manifestations associated with scleroderma (Shih et al., 2020; Strong et al., 2015). In this case, treatment outcomes were evaluated using the A-One Skin Analyzer following facial scar AFG treatment.

Riyat (2017), in a systematic review of 23 studies on autologous fat grafting, confirmed significant improvement in scar color, thickness, pigmentation, and pain following fat transfer, findings consistent with the biological mechanisms observed in this case, including ADSC-mediated tissue regeneration and paracrine cytokine activity. Bhooshan (2018) reported measurable improvement in scar quality among 34 patients treated with nanofat injection, 79.4% of whom had post-traumatic scars. Uyulmaz (2018) treated 40 scar cases with nanofat, with 76% of patients achieving adequate therapeutic response. In the present case, although reassessment of scar grade at Day 4 remains premature, baseline A-One Skin Analyzer data (pore size 0.23 mm and minimal elasticity) provide quantitative references for planned 3-month and 6-month follow-up evaluations, during which ADSC-mediated regenerative effects are expected to manifest as improved elasticity and pore refinement.

Several methods have been employed for harvesting adipose tissue prior to transfer, including vacuum suction, needle cannulas, and surgical excision. The deep subcutaneous fat layer is considered the optimal source of adipose tissue because it contains high concentrations of mature adipocytes with minimal contamination from non-adipocyte debris, erythrocytes, and skin appendages. The abdomen, buttocks, and hamstrings are all common donor sites. However, studies have demonstrated no significant differences in harvest weight, volume retention, or cell viability among these donor sites (Cohen et al., 2020; Shih et al., 2020; Tiryaki et al., 2020).

Fat may be harvested using dry, wet, or tumescent techniques. The dry technique does not require prior injection into the donor site and is commonly performed under general anesthesia because no local anesthetic is administered. The wet technique uses a fixed ratio of injectable

solution, usually a one-to-one ratio relative to the volume of harvested fat. The most commonly used method in practice is the tumescent technique, in which large volumes of injectable solution are infiltrated into the subcutaneous space to reduce bleeding, anesthetize the area, maximize fat collection, and minimize trauma. This procedure can be performed for both small- and large-volume fat harvesting and is particularly useful in liposuction and larger grafting procedures. In this case, fat was harvested from the abdomen using a syringe and gentle finger pressure to minimize adipocyte damage. Tumescent anesthesia was administered to reduce pain and optimize fat cell collection. No pain was reported during fat harvesting.

A systematic review of 23 studies evaluating fat transfer for scar treatment concluded that positive outcomes were achieved across both functional and aesthetic parameters, including scar color, thickness, pigmentation, and relief of pain and itching (Riyat et al., 2017). Scars associated with cleft palate repair and post-mastectomy reconstruction also improved after one or more fat-transfer procedures, suggesting that fat transfer may serve as an alternative to surgical scar excision in selected scar-related conditions (Riyat et al., 2017). Bhooshan (2018) investigated local nanofat injection therapy for scars and demonstrated improvement in scar characteristics and symptoms, with significant enhancement of scar rejuvenation. Their study included 34 patients (22 males and 12 females), with most scars being post-traumatic (79.4%). Photographic comparisons also demonstrated favorable aesthetic outcomes.

Nanofat grafting has also been shown to improve scars, wrinkles, and skin discoloration (Uyulmaz et al., 2018). In that study, 40 scar cases were treated, and 76% of patients achieved an adequate therapeutic response. Clinical assessments and scarring scales demonstrated significant post-treatment improvement in scar quality, accompanied by high patient satisfaction.

Yu (2018) transplanted nanofat and macrofat into the subcutaneous tissue of nude mice. After 12 weeks, the combination group demonstrated superior graft retention, higher capillary density per square millimeter, and better tissue architecture reconstruction compared with macrofat alone. The authors hypothesized that cotransplantation of nanofat and macrofat enhances neovascularization within grafted fat tissue and thereby improves fat graft survival compared with grafting without nanofat.

Yu (2018) further demonstrated that cotransplantation of nanofat and macrofat in nude mice achieved superior graft retention and capillary density compared with macrofat alone. This finding directly supports the combined microfat plus nanofat approach used in the present case, in which microfat provides structural volume while nanofat supplies ADSC-rich SVF to enhance neovascularization and graft survival. Although this mechanistic rationale is supported by the literature, direct extrapolation from animal models to human clinical outcomes requires confirmation through planned longitudinal follow-up. Therefore, this hypothesis should not be presented as a definitive conclusion.

Uyulmaz (2018) injected nanofat subcutaneously and suggested that it may be effective in treating atrophic scars. They treated patients aged 18–52 years with acne scarring using an average of two sessions of platelet-rich plasma (PRP) combined with nanofat, with some patients additionally undergoing fractional CO_2 laser resurfacing. The study found that PRP combined with nanofat, with or without laser treatment, produced very good clinical outcomes in acne scars and increased skin thickness.

Elsamongy (2020) concluded that nanofat transfer is an easy, inexpensive, and safe treatment for acne scars compared with the considerably more costly and labor-intensive nanofat-enhanced ADSC transfer. Approximately 70% of patients in both groups demonstrated excellent to very good improvement, and patient satisfaction reached 60% in both treatment groups. Histopathological examination demonstrated varying degrees of epidermal thickening with increased collagen and elastic fiber formation in both groups, although no statistically significant difference was observed between the treatment modalities (Elsamongy et al., 2020).

The prognosis *ad vitam* and *ad functionam* is good because the disease is not life-threatening and does not cause functional impairment. However, the prognosis *ad sanationam* is less favorable because complete resolution may not occur, and the risk of recurrence remains higher in this patient due to the mixed-type atrophic acne scars, which vary in morphology and significantly affect cosmetic appearance and daily quality of life.

CONCLUSION

This case report documents the clinical application of standardized *autologous fat grafting*, combining microfat and nanofat processed via the Lipocube® NanoKit-5 system, for the treatment of Goodman and Baron Grade IV mixed-type atrophic acne scars (ice-pick, boxcar, and rolling subtypes) in a 37-year-old female with Fitzpatrick skin type IV. The procedure was completed without intraoperative or postoperative complications. Follow-up on Day 4 demonstrated resolution of procedure-related edema and erythema, with no pain reported (VAS 0/10) and no adverse events at the donor or recipient sites.

While scar-grade reassessment at this interval is premature—because collagen remodeling and fat-graft integration require a minimum of 3 months—the early clinical course is consistent with a favorable safety profile. This case provides preliminary evidence that *autologous fat grafting* with microfat and nanofat is a feasible, minimally morbid intervention for mixed-type atrophic acne scars. The primary study limitation is the short follow-up duration; definitive efficacy assessment requires evaluation at 3 and 6 months using validated scar-grading tools and quantitative skin analysis. Prospective controlled studies with larger patient cohorts and standardized multi-timepoint assessments are necessary to establish the clinical role of this technique in the management of atrophic acne scarring.

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AUTHOR CONTRIBUTION STATEMENT

I Gusti Nyoman Darmaputra contributed to the conceptualization of the study, research design, data collection, analysis, and preparation of the original manuscript draft. Putu Akopita Devi contributed to the development of the methodology, validation of the results, and critical review and editing of the manuscript. Both authors have read and approved the final version of the manuscript.

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