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Fat Transfer During the Pandemic COVID-19 Time

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Franco Bassetto and Facchin Federico

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At the end of 2019, a novel coronavirus was recognized as the agent causing the outbreak of pneumonia in Wuhan, Hubei Province, China. The infectious agent was named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), while the disease was defined coronavirus disease-19 (COVID-19) [1, 2]. On March 11, 2020, WHO declared the spread of the infection as a pandemic. On May 11, 2021, WHO reported 3,277,834 cumulative deaths and 157,362,708 cumulative cases worldwide [3].

Patients affected by Sars-CoV-2 can be asymptomatic or show the clinical manifestation of the disease. Almost all patients develop symptoms within 12.5 days from virus exposure, while the incubation period reaches up to 14 days with a mean duration of 5.2 days [4–6].

Symptoms range from flu-like disease with fever, dry cough, myalgia, fatigue, and dyspnea to respiratory or multi-organ failure. Uncommon manifestations include diarrhea, abdominal pain, dizziness, productive cough, pleuritic chest pain, and hemoptysis. Skin manifestations have been reported in association to other most common symptoms or alone [4–6].

Furthermore, viral transmission has been demonstrated among asymptomatic patients [7].

The most common, efficient, and safe diagnostic tool used for viral RNA detection is real-time reverse transcriptase-polymerase chain reaction (rRT-PCR) performed on the nasopharyngeal swab. It has been recommended by the Center for Disease Control and Prevention (CDC) instead of most sensitive tools based on lower respiratory samples (i.e., bronchoalveolar lavage fluid specimens, brush biopsy, and sputum) for the lower risk of infection for healthcare workers, avoiding the creation of aerosol droplets [8–11].

During the first pandemic peak, almost all surgical procedures have been limited or postponed including fat transfer. The healthcare systems worldwide focused all their efforts on facing the pandemic limiting elective procedures like fat grafting [12].

In particular, during all surges in COVID-19 cases, plastic surgery departments were forced to limit their activity to allow healthcare workers' redistribution in COVID-19 treating units, to increase room availability for COVID-19 patients and to create intensive care units beds in the operating rooms [13].

The effective and forward-looking management of an epidemic outbreak provides, as a priority, the adoption of strategies aimed at the protection of health personnel and at the maximum containment of the transmission of the contagion between operators and patients.

The physical distancing in the workplace, the limitation of the duration of meetings, the use of personal protective equipment (PPE), and periodic screening of all personnel were effective in protecting operators in many departments worldwide [14].

In addition, hospital reorganization strategies showed positive results in allowing to perform urgent and oncological elective procedures minimizing the risk of infection [15].

Deferrable procedures for SARS-CoV-2-positive patients should be suspended for at least 2 weeks from the resolution

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of the infection, while patients at risk by symptomatology or history of close contact should be postponed for at least 2 weeks. Prolonged viral RNA shedding has been reported in the literature and it should be considered when programming the admission of a patient healed from the virus infection [16, 17]. On the contrary, positive patients requiring urgent procedures need to be treated in dedicated operative rooms.

During plateau phases of the pandemic, thanks to recent improvement of healthcare resources, elective surgery, including reconstructive procedures, should restart to address patients suffering from non-urgent diseases requiring treatment. Nonetheless, all patients undergoing operative intervention should be considered potentially infected asymptomatic carriers.

For this reason, specific preoperative screening is desirable. The history of the patient's general condition during the 14 days before the admission including respiratory or gastrointestinal symptoms, anosmia, or risk of exposure to virus need to be collected.

In addition, according to their availability, nasopharyngeal swab tests should be performed for a more sensitive screening of patients undergoing hospital admission.

In this way, maintaining a high suspicious index, medical staff could perform daily clinical tasks with basic personal protective equipment limiting the use of goggles, face shield, gowns, double-layered gloves, and protective footwear only for positive patients [14].

Fat transfer is included among deferrable procedures and it has been postponed during pandemic peaks in the majority of plastic surgery unit. However, giving its role in improving body shape, treating scars, and its regenerative scope to treat many pathological conditions, it should be restored as soon as other elective surgeries. In cases requiring aerosol-generating procedures, such as intubation and non-invasive/manual ventilation, PPE and transmission prevention should be carried out also in patients who screened negative [18]. On the other hand, the risk of infection is lower when aerosol-generating procedures are not required, such as in an outpatient setting.

As the vaccination campaign is proceeding, the risk of infection and virus transmission progressively reduces [19]. No surgical procedures have been associated with an increased risk for vaccine adverse event. However, Food and Drug Administration (FDA) reported adverse events in patients with dermal fillers receiving the SARS-CoV-2 mRNA vaccine [20]. Nonetheless, to limit the risk of in-hospital virus transmission, also vaccinated patients should be screened. In addition, it seems reasonable to program surgeries some days after the vaccination [21].

Indeed, a recent study suggests prioritizing patients needing elective surgery in vaccine administration. In fact, preoperative vaccination of patients needing elective surgical procedures over the general population seems able to prevent additional thousands of COVID-19-related deaths in 1 year [22].

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5 Fat Grafting as an Ancillary Treatment for Burns, Other Complex Wounds, and Their Sequelae

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Key Points

- The use of fat grafting has been incorporated on our everyday routine, changing our practice dramatically.
- In relation to burns and other wounds, there are several changes in our routine acute treatment, as well as after healing occurs, when fat grafting has greatly influenced the way we treat these patients´ acute wounds.
- These changes are even more noticeable in the way we take care of the resulting scar, since fat grafting has also greatly influenced the way we treat hypertrophic scars as a consequence of burn and other wounds.
- One of the most pleasant surprises in using fat grafts is the minimal incidence (or none) of hypertrophic scarring upon the healing of wounds treated with one or more sessions of fat grafting.
- In cases where no fat grafting was used to treat the acute wound, it can be used to treat the sequela and one can note improvement of the scar appearance as well as in volume, as early as 1–2 weeks after fat injection/fat delivery.
- We believe that the effect of fat grafting in treating wounds and/or scars is cumulative, meaning that repeat fat grafting will yield continuous, "overlapping" gain.

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5.1 Introduction

Fat grafting has become a common procedure in wounds originated from trauma and/or other causes. Fat contains Adipose-Derived Stem Cells and a great variety of growth factors which may have a direct effect in wound healing. Fat grafting has also been used successfully for the management of scars and post-trauma healing fibrosis, scarring, and pain. ADSCs may differentiate into fibroblasts, keratinocytes, and many other cells; they may also secrete mediators with neoangiogenic and anti-inflammatory properties. This would allow for it to act in all phases of the wound healing process as we understand it today. Fat on the lipoaspirate can be isolated and/or treated by physical or chemical methods, in the OR or in a laboratory setup [1–8].

As it was used more than a century ago to treat facial deformities, fat grafting was originally (re)introduced in the cephalic segment aiming at improvement in aesthetic aspects of the face and peri-orbit by Coleman in the early 1990s, and soon became one of the main options for disease, trauma, or post-surgery-related deformities [9, 10].

The use of fat grafting as an adjuvant treatment in acute and sub-acute burn and other wounds and in (chronic) vascu-

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lar wounds (venous insufficiency or diabetic arterial disease) attempts to take advantage of fat's benefits, when a great variety of metabolic and regenerative properties act increasing vascularization and enhancing the tissue regeneration process. When these wounds are treated with (repeated) fat grafting, healing is the planned outcome [11, 12].

When treating scars, the objective is to decrease the amount of hypertrophy (fibrosis), diminishing the scar thickness and increasing scar malleability. We also use this technique aiming at enhancing bone fracture healing, at decreasing fibrosis around bone joints, and at releasing tendon adhesions [13–15].

Additionally, when fat grafting is performed after the wound is healed, it will provide a compounded benefit, in decreasing fibrosis (on the surface, in the skin scar, and deep, around tendons and joints). This will occur regardless of the patient being previously treated with fat grafting or not [16].

Fat can be grafted (fat grafting) under the wound or scar, and fat can also be delivered (fat delivery) directly over the surface of a debrided wound or to scar or to skin surface, after microneedling or laser treatment [17].

The fat intended to be used in this technique of fat grafting and fat delivery is harvested from the patient him- or herself, via common liposuction techniques. The lipospirate may be treated by a variety of physical and chemical methods, or a combination of both.

In our institutions, we prepare and inject the fat via the Coleman Technique. We added fat delivery as a routine part of the procedure, aiming at an additional benefit, when we thought that the wound surface (or the substance of the scar) could also be influenced by direct contact with cells and factors concentrated in the centrifuged fat. The findings were remarkable, and we now use both fat grafting and fat delivery in the same surgical setting routinely.

The objective is to obtain full and prompt wound healing, while aiming at lesser fibrosis, and when treating scars, to obtain increased malleability and a progressive reduction of hypertrophic scarring.

5.2 Preoperative Evaluation and Special Considerations

5.2.1 Patient Selection

Patients with wounds or scars who are candidates for fat grafting procedure at our Service are those with:

1. Burn and other wounds with 3 weeks or more with no apparent progression to healing
2. Sub-acute burn wounds or other wounds who are transferred to us within more than 2 weeks after the accident or wound
3. Venous or diabetic ulcers
4. Decubitus ulcers
5. Wound cavities of any origin (avulsion, drained hematomas, tumor resection, etc.)
6. Shoulder, wrist, knee, and ankle tendinitis; post-fracture "bone pain"; major joint arthrosis, fracture lines on long bones on external fixation
7. Hypertrophic scars that are not improving or not being controlled by pressure garments at six or more weeks after healing
8. Patients with scar retractions over noble areas (tendons, nerves, or vessels) when fat is (pre)injected in these areas, aiming at "covering" the deep tissues when they could be exposed upon the incision release of the retraction

Patients with sub-acute burn wounds (more than 3 weeks in our Service) without apparent progression to healing and patients with hypertrophic scarring after healing of a burn or other type of trauma or keloids of any origin are also selected for treatment with fat injection/delivery. Repeat injections (up to four injections total) are performed at 7–10 days intervals for wounds or at 6–8 weeks intervals for scars. Fat is re-harvested each time a new fat grafting is performed.

The use of fat grafting as an adjuvant treatment in acute and sub-acute burn wounds aims at taking advantage of fat's benefits—a variety of metabolic and regenerative properties, increasing vascularization, and enhancing the tissue regeneration process. When these wounds are treated with (repeated) fat grafting, healing (with minimal fibrosis) is the planned outcome. When treating burn and other scars, the objective is to decrease the amount of hypertrophy (fibrosis), diminishing the scar thickness and increasing scar malleability [17, 18, 19].

In patients with chronic wounds, as part of the general preoperative evaluation, fragments of the wound are obtained for culture and sensitivity. These patients very frequently will carry multi-resistant organisms on their wounds, since the vast majority have received treatment in one or more institutions prior to our evaluation. We know the inhabitant flora will aid in the perioperative antibiotic selection, while not precluding performing the procedure.

The actual surgical procedure is performed in the Operating Room, following all rigors and care for sterile procedures.

5.3 Surgical Technique

Fat harvesting and fat injection are sterile surgical procedures and should be performed only in accredited operation rooms under rigorous, completely sterile technique. Patients are submitted to general anesthesia or regional block.

5.3.1 Donor Areas

Donor areas are "rotated" as needed and fat most frequently is obtained from the thighs or lateral upper buttocks—less frequently from the abdomen (when we obtain fat from the abdomen, we first order an ultrasound of the abdominal to verify the presence or not of wall defects and/or hernias, which could preclude the use of this area as a donor area).

When necessary, shaving of the pubic area or proximal thigh is performed in the OR, immediately before the procedure. Puncture incisions for introduction of the liposuction cannula are placed on the midline, at the suprapubic crease, or medial to the femoral pulse, at the inguinal crease, or in the middle axillary line, at the upper border of the iliac bone.

5.3.2 Fat Graft Harvest

The actual volume of harvested lipoaspirate should be at least twice the anticipated volume planned to be injected, and at least four times this volume, if one is also planning to have fat delivered over the wound or the scar.

5.3.3 Patient Positioning

Patients are supine when using the abdomen or thighs as donor areas or on lateral decubitus when obtaining fat from the lateral upper thighs. Fat is usually injected and delivered while the patient is supine. In paraplegic patients with decubitus pressure orders or patients with wounds in the back, fat is usually harvested with the patient supine and then the patient is repositioned into a lateral or prone position as needed.

5.3.4 Recipient Site Preparation

In patients with open wounds, the donor area is initially prepped and draped and fat is then obtained by liposuction; only after the planned amount of fat is obtained, the recipient area is then prepped and draped, while the obtained fat is being centrifuged and distributed into various 1-cc syringes.

In patients with scars (healed wounds), the donor area and recipient area are individually prepped and draped in the usual manner.

5.3.5 Fat Harvesting

Fat is harvested from the patient him- or herself, using a 10-cc Luer Lok syringe, attached to a 3-mm canula, with multiple (8–12) distal side openings, with 10, 15, or 20 cm length, according to the harvesting site. In children weighing less than 25 kg, as well as in ladies with relatively thin thighs, we prefer 20-cc syringes and a 2.5-mm cannula, also multiperforated distally. In these smaller patients, these cannulas will enforce a higher negative pressure assuring a more even and efficient fat harvesting, respectively. Occasionally in very small patients (our smallest patient weighted 8.145 kg) or in the elderly (our oldest patient was 89 years old), it may be necessary to harvest fat from more than one donor site.

As recommended by Coleman, one or more distally plugged 10-cc syringe containing the obtained fat is/are centrifuged at 3000 rpm for 3 min on a 30-degree angle centrifuge (1200 G's). The obtained compound has a top layer of oil, a middle layer of fat (with the SVF within, at its lower portion), and an aqueous inferior layer. The top layer of oil is discarded while the plug still is on the syringe. The plug is then removed and the aqueous layer drains out per gravity. The remaining compound is sequentially injected anterogradely into "insulin" syringes without the plunger, which is then replaced (Fig. 5.1).

5.3.6 Fat Grafting/Fat Delivery

A perforation is made at an acute angle in healthy skin in the periphery of the wound or the scar using a 16-gauge needle. A 1.8 mm outside diameter 70-mm-long cannula already connected to a Luer Lok 1-cc syringe is inserted through the needle puncture hole and (forcefully, if needed) driven immediately under (or through) the wound bed or the scar. Fat is then deposited in a retrograde manner, in several "passes" until the entire area is grafted (via as many puncture sites as needed around the periphery of the scar or wound). On average, 1.8–2.5 cc of centrifuged fat are injected per each 10 cm^2 area and it is necessary to make 25 to 30 "passes" to inject 1 cc (Fig. 5.2).

Occasionally when there are fracture lines of bone loss "voids" or exposed bone, fat will be injected through the wound into the fracture line. After the wound area has been completely (undersurface) grafted, the surface of the wound is thoroughly debrided and fat is deposited in enough quantity to cover the entire wound. We usually debride the wound only after the undersurface has been grafted because, by doing so, we avoid having to do multiple punctures around a bleeding wound or running the risk of moving debris along with the injection cannula under the wound. In deeper burn wounds, the dead tissue must be excised, even if tendons or nerves will be exposed – centrifuged fat is then delivered locally covering these noble structures.

An average of 3.5 cc of centrifuged fat is delivered per each 10 cm^2 wound area and the fat is delivered in a zig-zag manner directly over the entire surface of the wound, using a 1-cc or 10-cc syringe connected to a 1.8-mm/70-mm cannula.

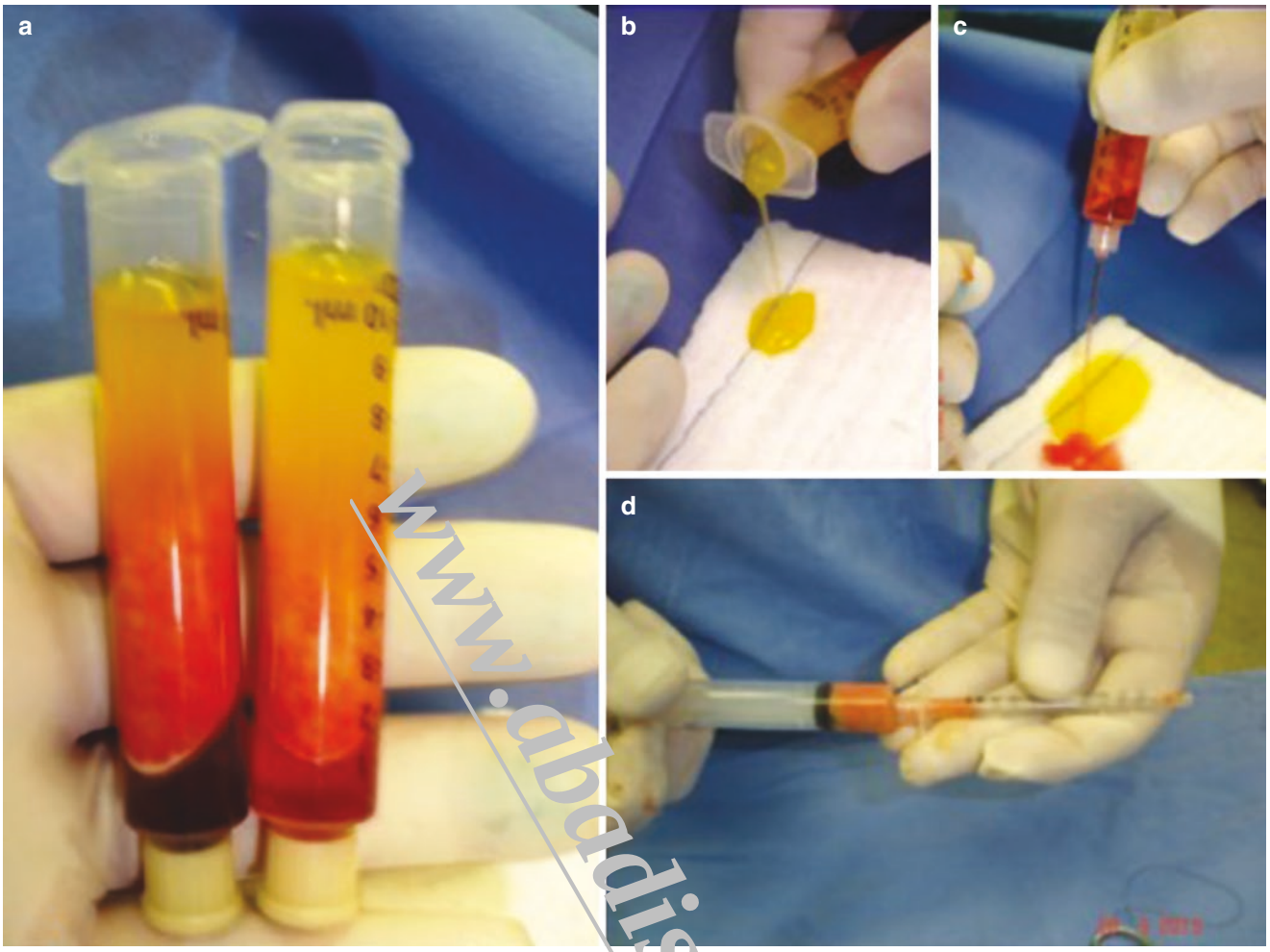

Fig. 5.1 (**a**–**d**) – Centrifuged lipoaspirate, discarding oil and aqueous layer and filling "insulin" syringe

After the wound area has been completely (under)grafted, the surface of the wound is thoroughly debrided and fat is deposited in enough quantity to cover the entire wound. If bone (with or without periosteum), tendons, or nerves are already exposed or exposed after debridement, fat is delivered directly over any or all of these structures (Figs. 5.3 and 5.4).

When treating scars, centrifuged fat also treated by the Coleman Technique is injected immediately under the substance of the scar. Fat is injected through as many puncture holes and directions necessary to "cover" the entire undersurface of the wound or scar. The cannula will run immediately under the scar tissue. After fat grafting is complete, the scar surface area is treated with a dermaroller (usually with 0.5–1.5 mm needle length) or the scar surface may be treated with a fractional CO_2 laser, opening "pores" or holes, through the epidermis, into the substance of the scar. Centrifuged fat is then delivered directly to the treated surface (average 3 cc/10 cm^2) (Figs. 5.5 and 5.6).

Very frequently, in scar cases, we will combine one or more partial intralesional scar resections and primary suturing with fat grafting immediately under the suture line, as well as under the entire surface of the scar. In these cases, one may also roll the dermaroller over the sutured area and the surface of the scar and also provide centrifuged fat delivery.

Partial scar removal and fat grafting/fat delivery are associated very frequently. In these cases, we perform the partial scar resection first, keeping the resection within the scar substance (trying not to go into subcutaneous tissue). A running nylon suture closes the surgical wound. Fat is injected under the entire scar surface, including under the suture line. Surprisingly, all these patients who are originally healed from a facial burn with variable amounts of hypertrophic

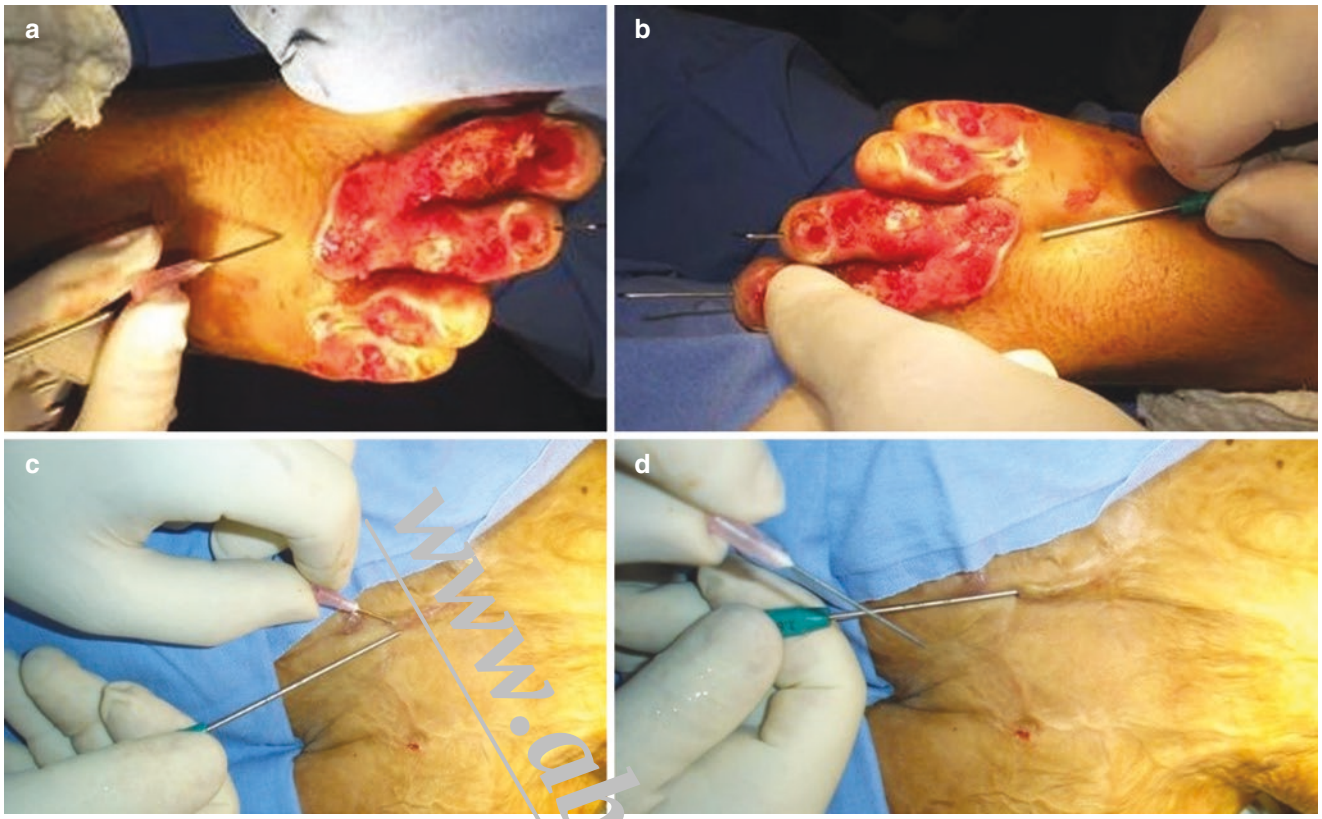

Fig. 5.2 (**a**, **c**) A puncture on the skin peripherally to the wound / scar is made with a pink (18 gauge) needle; **b**, **d**—the injection cannula is then inserted via the needle puncture site

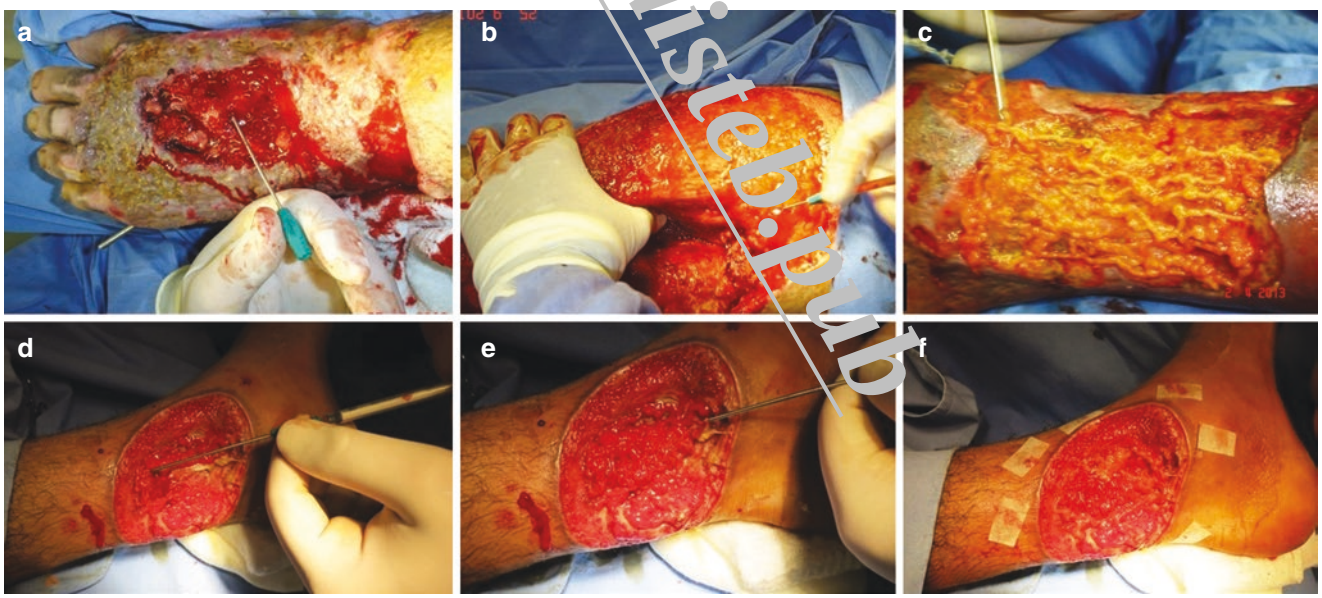

Fig. 5.3 (**a**) Cannula penetrating through the wound into bone fracture line; (**b**) cannula penetrating though the wound (and muscle) delivering fat to wound cavity; (**c**) fat being delivered to wound surface after debridement; (**d**–**f**) fat being delivered to debrided wound covering exposed nerve and tendons