

Autologous Fat Transfer: Eliminating the Centrifuge, Decreasing Lipocyte Trauma and Establishing Standardization for Scientific Study

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Introduction: The autologous fat transfer procedure has undergone a renewal of interest because of the need for larger quantities of economical filler (face, buttocks, hands, and breasts). Commercial fillers are cost prohibitive when large quantities are needed. Present instruments on the market are not specialized enough to perform well during the autologous fat transfer procedure. As a result, multiple techniques have evolved that produce extremely varied results that are not scientifically verifiable. The objectives of this paper are to (1) review the events that are traumatic for the lipocyte and review how those events can be improved through new instrumentation; (2) review the use of the centrifuge and consider replacement of the centrifuge with an effective filter system; (3) establish instrument standards that will encourage scientific technique verification; and (4) introduce a standardized autologous fat transfer instrument that will save time, reduce significant trauma, and have standardized features to promote accurate scientific study.

Methods: Information was obtained via a questionnaire, internet investigation, trade show information, personal discussions with surgeons, and the author's experience. Information from the questionnaire was used in the design of a new, improved standardized instrument.

Results: During this study, an instrument was designed that would reduce operating room time considerably. Most of the time reduction was secondary to keeping the fat in the harvest syringe without transferring or centrifuging. This change in procedure would also considerably reduce lipocyte trauma in all 12 of the commonly accepted lipocyte trauma categories. In addition, the instrument could be standardized with multiple features that would give the surgeon confidence that the surgical results would not change because of the instruments.

Conclusions: The Tissu-Trans™ device that was designed during this study significantly saves time, simplifies the procedure, and has standardized features that allow for scientific studies that are more accurate. The equipment offers simplicity and "feature latitude," allowing the surgeon to perform all of the major steps (harvest, filter, irrigate, treatment, and reinjection) from a single harvest syringe. Although all 12 of the traumatic events for lipocytes were reduced in intensity, one should not leap to the conclusion that this correlates with increased lipocyte survival. To date, this has not been proven. Further clinical testing will be necessary to obtain this information.

The autologous fat transfer (AFT) procedure, also known as fat injections, fat transplantation, fat microlipoinjection, volume restoration, tissue enhancement, and liposculpture, has undergone a renewal of interest. The use of fat as a filler substance has been used for many years. However, because of unpredictable results, it became varied in its popularity. The instruments and techniques were not refined to the level needed and surgeons turned to the commercial substances that were gradually entering the market. A small percentage of surgeons dedicated to AFT have devised techniques and additive solutions to gain acceptable results.

Presently, there are several commercial filler substances on the market. These filler substances include Restylane, Collagen, Sculptra, and Hyalaform, to name a few. These substances serve as good fillers for small areas, but the cost for larger areas can become prohibitive for most patients (>\$200/mL; range, \$100–\$400/mL). For this reason, as well as the easier acceptance by the patient of their own fat, surgeons have now begun to re-evaluate the use of autologous fat.

The cosmetic surgeon is well aware of the many events that can damage the lipocyte. For reasons not

entirely understood, fat transfer has had a history of yielding unpredictable results.¹⁻²⁶ We can now list more than 12 events that are most likely traumatic for the lipocyte, but the extent of each traumatic event has not been defined. The instruments and devices available to the surgeon today are the same instruments that are used in the conventional liposuction procedure. These conventional instruments were not designed with concern for protecting the lipocyte in mind. They were designed based on the premise that the fat will be discarded, not preserved and reused. As a result, these conventional instruments damage a large percentage of the fat cells. The cosmetic surgeon interested in AFT needs instruments that are customized for adipocyte survival and needs simplified, time-saving techniques.

Recently, the field has been subjected to requests for larger volumes of substances for full facial, hand, buttocks, and breast fat filler. Artificial fillers are now available, but because of the larger volumes necessary in these areas, they become unaffordable to most patients. AFT has been revisited in an effort to use unwanted fat from other areas as the fill for areas of need. However, with AFT, the cosmetic surgeon is faced with a procedure that tests the patience of the surgeon because it is methodical, time consuming, and neither the instruments nor the technique have been standardized.

Considerable progress has been noted by surgeons explaining exactly what happens when fat is transferred. Some investigators have shown evidence that the implantation of dead cell-wall collagen can stimulate more collagen deposition.^{8-11,18,22} Kaminski has shown evidence of increased survival secondary to meticulous technique and the use of oncotic additives to protect the lipocyte, and Alexander¹²⁻¹⁴ has indicated that protein-rich platelets can encourage survival. Flores-Delgado has used thyroid to stimulate adipocyte growth and Bircoll has used insulin.^{14,15} However, the circumstances leading to the successful survival of the lipocyte and the process of additional collagen deposition are difficult to evaluate because every surgeon is using a different technique with different instruments. Because of these variances and unpredictable results, few surgeons perform the fat-transfer procedure on an ongoing basis. However, judging by the increase in the papers and talks on the subject, the procedure is being revisited by many surgeons.¹⁻²⁶

The objectives of this paper are to (1) review the events that are traumatic for the lipocyte and review how those events can be improved through new instrumentation; (2) review the use of the centrifuge

and the replacement of the centrifuge with an effective filter system; (3) establish instrument standards that will encourage scientific technique verification; and (4) introduce a standardized AFT instrument that will save significant time, reduce significant trauma, and have standardized features to promote accurate scientific study. In this paper, the term "technique time" is the time it takes during AFT to harvest, transfer, centrifuge, irrigate and/or add additives, and reinject 10 mL of fat.

It is not within the scope of this paper to include the extent of lipocyte survival after each step in the AFT procedure. Although it is logical to assume that when a reduction in a known traumatic event occurs there should be an increase in lipocyte survival, further clinical studies are needed before such claims can be made.

Methods

The information for this paper was obtained from a questionnaire answered by 35 surgeons performing AFT, from an extensive study of the surgical literature, from lecture information, from discussions with surgeons, and from the author's professional experiences (Table 1).¹⁵⁻¹⁶ This information was the background information for the development of the Tissu-Trans instrument. This instrument was planned, designed, prototyped, tested in the lab, redesigned, reprototyped, tested in the operating room, approved by the Food and Drug Administration, patented, and manufactured by Shippert Medical Technologies, Centennial, Colo.

Results

Questionnaire and Literature Results

The questionnaire that was sent out revealed many interesting facts. Most of the 35 surgeons questioned did not use the centrifuge or a wash, and they did not do so mainly because of the time it took to perform these steps. Table 1 presents a summary of the questionnaire findings. Also, although, in general, there were as many techniques as surgeons performing them, there were 4 common methods for performing the procedure, and the most common technique was to harvest and reinject the fat cells without any treatment or additives (Table 2).

Instrument Design

During this study, an instrument was designed (ie, the Tissu-Trans) that would include all of the ideal features for a fat-transfer device. The Tissu-Trans is an instrument that was designed to significantly shorten the time of the AFT procedure, to lessen the trauma to

Table 1. Survey of 35 Surgeons and Their Basic Techniques

Most Surgeons:

- Used tumescent technique
- Harvested with a 60-mL syringe
- Transferred fat into other syringes at least once
- Harvested with a 3- to 5-mm outer diameter cannula
- Did not wash/irrigate
- Did not centrifuge
- Did not treat fat with an additive
- Reinjecting with a 10-mL syringe
- Reinjecting with a 14- or 16-gauge needle/cannula
- Reinjecting with a Coleman Type II hole pattern

the lipocyte, and to contain built-in standardized features that would allow scientific study.

The events in Table 3 are those considered traumatic for the lipocyte. Each event is addressed by the new Tissu-Trans device. Although it is probable that the following causes of trauma are accurate, the extent of the damage of each traumatic event has not been established, and awaits further investigation. Now that a standardized device is available, these areas can be investigated more accurately. Table 3 summarizes the traumatic events that are accepted by most surgeons today and outlines the manner in which the Tissu-Trans device addresses the traumatic events.^{10,11,16,19–21,26}

- **Shortening the “technique time”:** Information gleaned from the questionnaire and from personal interviews indicated that it usually takes most surgeons too much time to harvest, process, and reinject fat. Although the time seems to vary from surgeon to surgeon, the “technique time” for performing the AFT procedure was 10–36 minutes (per 10 mL of fat), with the lesser number being obtained by the surgeons that were harvesting fat and reinjecting it without any processing and the longer times including those surgeons who had more processing steps and centrifugation (the “tech-

Table 2. Variations in Steps: Most Surgeons Harvested and Reinjecting Without Washing or Centrifugation

| General Steps | Percentage of Surgeons (Rounded) |
|---|----------------------------------|
| Harvest and reinject | 75% |
| Harvest, wash, and reinject | 17% |
| Harvest, centrifuge, add additive, and reinject | 1% |
| Harvest, wash, centrifuge, and reinject | 7% |

Table 3. Lipocyte Traumatic Events: The New Device Is Designed To Address All of the Traumatic Events, Each to a Varying Degree

| Traumatic event for the lipocyte | Features of the Tissu-Trans that address the traumatic event |
|---|---|
| Small-bore constricted conduits and passageways | Conduits and passageways standardized at 0.100 in |
| Centrifugal force | Replaced centrifugation with an effective filtering system |
| Long tubular passageways | Tubing eliminated |
| Multiple transfers | Transfers eliminated |
| Vacuum power too strong | Unit designed to function down to 10 in Hg |
| Air and UV rays | Fat enclosed in polymer throughout procedure |
| Hypotonic or hypertonic solutions | Irrigation with normal saline |
| Stirring and scraping | Eliminated need for stirring and scraping |
| Triglycerides, epinephrine, and xylocaine | Irrigate (option) while harvesting |
| Sepsis | Fat stays in original syringe during harvest, filtering, irrigation, addition of additive, and reinjection; unit is disposable and γ -sterilized. |
| Inadequate fat parcel size | Cannulas are 0.100 in and hole patterns are 0.100 \times 0.200 in to produce a rice kernel-size fat parcel |
| Inadequate nourishment for fat parcel | Additive option during or after harvest Additional features: <ul style="list-style-type: none"> ● Significant time savings ● Constructed with latitude for many techniques ● Ease of filter change ● Economical |

nique time” of 10–36 minutes was taken from the survey of 35 physicians performing the AFT procedure and it is NOT only the centrifugation time; it includes the range of time from harvest through reinjection and, thus includes the time to harvest, to treat with additive, to irrigate, to transfer, to centrifuge, and to reinject the fat).

Table 4. With Older Instruments, 6–8 Steps, 10–36 Minutes Are Needed

- Step 1:** Liposuction fat from the donor area into a 60-mL syringe.
- Step 2:** Transfer fat into several smaller syringes that will fit into a centrifuge. Place caps on the ends of the syringes to prevent loss during centrifugation.
- Step 3:** Centrifuge fat (time and speed variable).
- Step 4:** Pour off the top liquid oil level from the centrifuged specimen.
- Step 5:** Place the plunger in the syringe, tip the syringe upward, and expel the red cells and debris, leaving the residual fat in the syringe. Repeat (including repeat centrifuging) twice if necessary for proper separation. Some surgeons add additional saline to wash the lipocytes and add saline again before the centrifugation.
- Step 6:** Add additive (if used).
- Step 7:** Remove excess moisture with an absorbent neuro pad or a PVA foam pad.
- Step 8:** Replace plunger in an injection syringe, place an injection needle on the tip, and inject the fat. Conventionally, this injection is manual, with a standard plunger/syringe or a special dental manual mechanical gun.

Table 5. New Instrument Steps: With the New Tissu-Trans Instrument, 3 Steps, 2–3 Minutes Are Needed

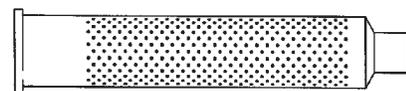
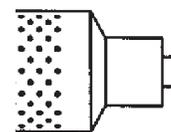
- Step 1:** Tissue is removed from the donor site with the special syringe that filters with walls, which have numerous 0.020-in holes. This unit allows the fat to go directly into the same inner syringe that will ultimately be used for injection. The special construction allows the oils and cellular debris to pass on through the syringe, whereas the fat parcels larger than 5 lipocytes stay in the harvest syringe. Irrigation can optionally be performed concomitantly. The fat is ready to be injected in this form, or the surgeon can proceed to step 2 if an additive is desired.
- Step 2:** Any desired liquid additive can be instilled into the syringe containing the fat. *This can be done after harvest or instead of the wash phase.*
- Step 3:** Fat is injected into the desired area of the body. This can be performed manually or with a mechanical gun.

The design of the Tissu-Trans includes the elimination of the centrifugation step, replacing centrifugation with an effective filter. This is the most difficult part of the design because it involves a delicate balance between the viscosities of the material being harvested, the power of the suction, the number of filter holes, and the size of the filter holes. By making the time shorter through the elimination of the centrifugation step, the Tissu-Trans also eliminated several transfer steps and reduced the usual 8 instrument steps in the procedure down to 3 steps (Tables 4 and 5). These three steps can usually be performed in less than 2 minutes.

- **Filters to replace the centrifugation:** The Tissu-Trans design has an effective filter that eliminates the centrifugation step. The filter is made from polypropylene and forms the actual wall of the 10-mL syringe. The filter has 760 holes that are 500 μm in diameter (Figure 1). One fat cell is approximately 100 μm (range, 80–120 μm). This filter allows all liquid (triglycerides, epinephrine, xylocaine, and blood components) and debris as small as 5 lipocytes (lipocytes vary from 80–120 μm) to pass through the filter as waste.
- **Reduction of the number of conduits for the fat to pass through:** Because trauma is created every time

the fat parcel is forced through a conduit, it is obviously better to have fewer conduits. The device has only one conduit (Figure 2), which is used first during the harvest and used again during the reinjection phase. This instrument eliminates multiple transfers completely; thus, will reduce the trauma associated with those transfers.

- **Creating uniformity of the internal diameter of all the conduits and cannulas:** The device has a standard Luer-lock coupler end on the syringe that was increased and standardized at 0.100 inches to give maximum flow and still maintain the security of a Luer lock. This device also offers a harvest cannula that is standardized to the Luer-lock coupler, by

**Figure 1.** Multiholed harvest syringe.**Figure 2.** Luer tip is the only transfer and the tip has been increased in internal diameter to 0.100 in.

making the cannula internal diameter also 0.100 inches. These larger passageways (cannulas) are very practical for the body-fat transfers, but perhaps not practical in all areas. For example, the larger cannulas cannot be used in areas, such as the eyelids, in which smaller fat reinjection needles would be required. However, whenever cannula/needles with an internal diameter smaller than the internal diameter of the harvest cannula must be used, the surgeon must accept the fact that there will be additional pressure trauma to the transplanted specimen.

- **Creating a “rice kernel” patterned hole size at the distal end of the harvest cannula:** Georgio Fischer²⁵ has indicated that a fat parcel the size of a rice kernel has a better chance of establishing a blood supply.¹⁹ The size of a rice kernel is approximately 0.100 in × 0.200 in. However, this has not been proven to be of benefit and further study is necessary. The standardized harvest cannulas (Figure 3) as well as the standardized reinjection cannulas have a hole pattern that will allow this maximum size for a fat parcel (Figure 4).



Figure 3. Harvest cannula tip.



Figure 4. Reinjection cannula tip.

- **Reducing the tubing to zero:** This traumatic event is reduced to zero by eliminating the need for the fat to pass through *any* tubing at all. The fat passes from the harvest cannula directly into the filtering syringe, thus, no tubing is used at all.
- **Performing irrigation during the harvesting (Figure 5):** Performing either irrigation or additive treatment during the harvest is a time saving new

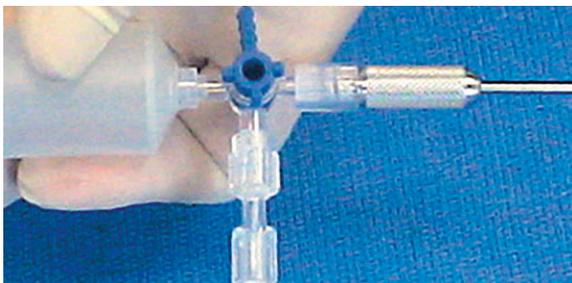


Figure 5. “T” valve for irrigation.



Figure 6. Additive injected into fat-filled syringe.

technique. So that irrigation can take place during the harvest (saving further time) a “T” was installed between the harvest cannula and the harvest syringe. The T is connected to a normal saline IV.

- **Treating with additive during or after the harvest (Figure 6):** Alexander and Kaminski.^{12–14,22–24,26} have suggested (and supported with scientific reports) the concept that certain additives, such as platelet-rich plasma, albumin, and others, can help lipocytes survive at the recipient site (Tables 1 and 2). If the surgeon chooses to add an additive, this can be performed with a syringe and a 3.5-in needle. The needle is inserted into the harvested fat and the additive is expelled as the needle is withdrawn.
- **Eliminating the high vacuum pressure (Figure 7):** The power of a full atmosphere (29.5 in Hg at sea level), as is used for conventional liposuction, is destructive to a high percentage of the lipocytes. If the cells survive the trip to the canister, they encounter the far wall of the canister at high speed. The Tissu-Trans device was built to function well at 10–20 in Hg, with the recommended level being 15 in Hg. This is even lower than the conventional “wall suc-

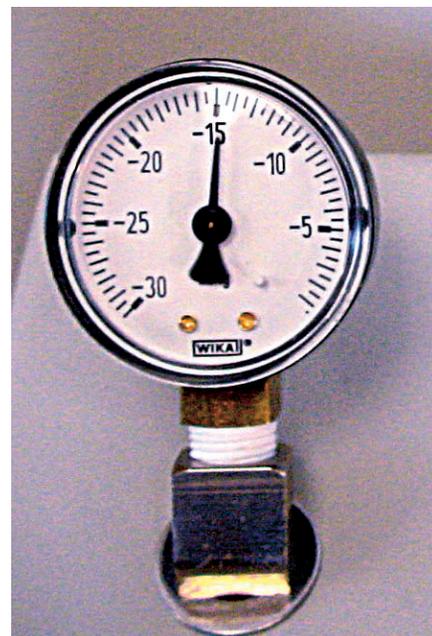


Figure 7. Gauge showing reduced vacuum power.



Figure 8. *Fat in harvest syringe.*

tion” or the Gomco pump found in most hospitals. Whichever pump is used, it should have an adjustable gauge so that the pressure can be adjusted down to 10–15 in Hg.

- **Eliminating stirring and scraping:** Stirring or scraping accompanies transfers and open irrigation. Throughout the procedure, the fat is encased in the inner harvest syringe (Figure 8). The fat is harvested, irrigated, treated, and reinjected back into the body without ever touching anything except the inside of the 10-mL syringe. Because no transfers or open irrigation is required, all scraping, stirring, and handling is automatically eliminated.
- **Preventing sepsis (Figure 9):** Sepsis, although uncommon, is one of the historically accepted lipocyte traumatic events. The chance of sepsis increases whenever the fat is repeatedly handled, transferred, exposed to air, leaves the sterile field, or when instruments are manually cleaned. This new device is designed so that the fat stays in the syringe throughout the entire procedure to lessen the pos-



Figure 9. *No centrifugation.*



Figure 10. *The Tissu-Trans for autologous fat transfer (AFT).*

sibility of sepsis. Sepsis is further lessened by the economical disposable construction of the Tissu-Trans, which is constructed of disposable polymers, and the product is sterilized by γ -radiation.

- **Allowing a multiplicity of techniques:** The Tissu-Trans has been constructed with enough latitude that most of the present techniques can still be used. The device was manufactured in this manner so that it would not limit research on techniques. By having a standardized instrument that is customized for AFT, we are one step closer to gaining scientific information regarding the best techniques. If a surgeon uses a standardized instrument for all of the fat-transfer procedures, any changes in results are most likely not attributed to the device (Figure 10).

Discussion

AFT is becoming more and more popular because of patient requests for full facial rejuvenation, hand rejuvenation, breast augmentation, and buttock sculpturing. All of these areas can involve large-volume transplantation, and if artificial substances are used, the costs can become prohibitive for most of the patients. Patients are more sophisticated in their requests today and they prefer natural substances taken from their own body. They are also aware of the cost advantage when they use their own body fat. Their requests are logical and their requests underline the need for change, but, until recently, the technology has not kept pace with the need. The industry needs customized, standardized instruments for improved fat transfer.

The improved AFT technique involves saving significant time, reducing significant lipocyte trauma, and standardization of the instruments so that the surgeon can have confidence that the mechanical aspect of the procedure will always be the same. If one wants to improve the results, it will be important to pay attention to these important areas. The “technique time” includes the harvest time, the treatment of choice (irrigate, additive, and centrifugation) time, and re-injection times combined. Going from a technique that has 8 steps with the technique time range of 10–36 minutes per 10 mL of fat, down to 3 steps and less than 2 minutes technique time, is a very significant change.

Although further research will indicate how much better the AFT results are with standardized instruments, there is no doubt that the surgeon will be more likely to perform the procedure to begin with knowing that they can perform it easily in a reasonable time.

The development of the new Tissu-Trans device is the direct result of the findings of this study. It considerably reduces the time to perform the AFT technique. It addresses all of the traumatic events, each to a varying degree, by either reducing or eliminating the event. The standardized features give the surgeon the confidence that any change in results would be secondary to technique and not because of instrument differentials.

Although it is logical to assume that when a reduction in a known traumatic event occurs there should be an increase in lipocyte survival, further clinical studies are needed before such claims can be made.

Acknowledgments

Although Dr Shippert potentially has a duality of interest, his presentations to date and the papers authored have always been balanced and scientific. The nature of his work in new product development and the content of his writing usually entail the factual comparison of products that are in the marketplace. This is of great help to the busy practitioner who desires comparative information but lacks the time to investigate. When competing products are present, a scientific balanced approach is always presented. When no competing products are present, a thorough scientific description of the existent product is presented. The funds and labor for the research on this project was provided by Shippert Medical.

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