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Facial Multilayered Micro Lipo-Augmentation

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ABSTRACT: Lipo-transfer to the face is a procedure that can produce remarkable improvements in facial aging utilizing a step-by-step, simplistic technique performed alone or in combination with other rejuvenating procedures. Long-term survival rates of 3–5 years can be achieved when certain scientifically proven principles of fat neovascularization are respected and attention is paid to the fine technical details involved in harvesting and replanting fat grafts. During the past 5 years, approximately 2500 cases (1300 K.B. and 1200 J.N.) of fat transplantation have been performed to the face and the body. From this experience, we have clinically observed that the following principles can improve the long-term survival rate of transplanted fat: 1. Smaller volume fat transfers performed sequentially on two to three separate occasions at 4- to 5-month intervals have proven to be the most consistent factor influencing fat survival. 2. Reharvesting from the same site during each successive transfer appears to increase the percentage of fat survival. We hypothesize that this may be influenced by a histologically proven collagen surge seen at the previously suctioned donor area. 3. The quality of the fat graft removed from the donor site is greatly influenced by size and design of the harvesting canula, technique of liposuction, and method of transference back into the recipient site. 4. Fat transfers of less than 3 mm in diameter placed in multiple cylindrical tunnels using a fan-shaped pattern survive better than a single large volume transplant placed in one spot. 6. And finally, multilayered transplantations placed from the submuscular plane to the superficial subcutaneous plane will create the most evenly distributed micro lipo-transplantations that have the best opportunity to obtain a new vascular supply and survive the longest.
Key Words: Multilayered lipo-transplantation, Harvesting, Fat transplant, Long-term survival

Facial aging is influenced by loss of skin elasticity and even more importantly by atrophy of subcutaneous fat in certain areas of the face. This results in loss of volume and fullness, which does not allow the skin to comfortably drape over the diminished facial framework, thus creating the illusion of facial sagging and wrinkling. Therefore, the answer to facial rejuvenation is not only skin pulling and/or tightening, but also volume refilling of the atrophied areas. In many cases lipo-augmentation may be the only procedure necessary to naturally recreate harmony and youthfulness.

With the development of liposuction in the 1980s, it became possible to perform facial augmentation by utilizing fat transferred from one area to another. We have seen the pendulum swing from great enthusiasm with fat transplantation in the mid 1980s[1–4] to increasing criticism and disappointment in long-term survival rates by the late 1980s and early 1990s.[5,6] Many surgeons lost interest in fat transplantation and looked to simpler methods such as collagen, microdroplet silicone injections, Gor-Tex grafting, and Silastic facial implantation as a means to improve this loss of subcutaneous fat. However, within the last several years we have seen these more popular techniques begin to manifest their own idiosyncratic complications, such as immunological reactions to collagen with almost

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complete reabsorption necessitating reinjection every 4–6 months, development of silicone granulomas, displacements and/or infections (over the long and short term) with facial implants, and extrusions or infections with Gor-Tex grafting.

As with many surgeons, we attempted to use these materials with great enthusiasm in the beginning but found ourselves plagued with these bothersome complications. As minor and infrequent as they may have been, we were forced to resolve these problems by offering yet another procedure to correct what had already been done. Consequently, we found ourselves returning to fat transplantation because of its natural consistency, ease of transfer, and decreased incidence of complications.

We believe that the success and long-term survival rates of fat transplantation can be achieved by following certain technical and scientifically proven guidelines that require finesse, soft touch, and artistry. By following these principles, we have objectively observed a 30–50% long-term survival of fat transplanted to the face over a 5-year period in more than 2500 cases (1300 K.B. and 1200 J.N.) performed from 1988 to 1996.

TECHNICAL CONSIDERATIONS

Recipient site

Aging of the face is most notable by fat wasting and deepening of wrinkles in the forehead creases, glabellar creases, nasal labial folds, cheeks, lips and the jaw lines, all of which can be reaugmented with fat transplantation. Other areas such as traumatic depressions, acne scars, buccal fat wasting, facial asymmetries, and senile earlobes can also be improved with fat transplantation. In addition, we have used these same principles for body rejuvenation of penile hypoplasia and atrophy, fat wasting of hands and heel fat pads, and atrophy of the labia and mons pubis.

We have avoided utilizing fat transplantation to the breast, primarily because of the potential chance of cyst formation with subsequent calcification requiring biopsy to rule out carcinoma. And secondly, as a consequence of the high reabsorption rate of fat, patients become very disappointed with the rapid decrease in breast size during the first 6 months after augmentation.

Similar problems have been encountered with fat transplantation to the penis where firm tender cysts, as well as irregular reabsorptions in different areas, have resulted in a misshapened penis, which are quite distressful and disappointing to patients. Therefore, we are very conservative in our indications for "male organ enhancement."

Age

Different age groups present to our office with complaints of different problems that have been corrected with our technique of multilayered microlipo-augmentation, ranging from ages 14 to 87 years old, with the majority being 35–50 years old. Patients 18–30 years old usually request and undergo lip augmentation. Patients between 35–50 years old usually notice the first signs of aging as loss of fullness in the lips and the cheeks, deepening of the nasal labial folds, and development of the marionette lines, all of which can be corrected with lipo-augmentation. Acne scars are also more apparent in this group because aging and fat atrophy make the scars appear more depressed. Patients 50–65 years old generally undergo fat transplantation as an ancillary technique to compliment more definitive procedures such as facial liposuction, platysmal sling, chemical peeling, CO_2 laser resurfacing, and face lifting. Patients 65–80 years old have usually undergone other definitive procedures and request fat transplant as a less invasive and less costly procedure that can compliment what has already been done.

Donor site

Seventy-five percent of our fat transplants are harvested from the abdominal area through a suprapubic or transumbilical incision. It appears grossly and clinically that the quality of fat has more structural integrity, is easier to harvest, and is associated with less secondary liposuction deformities than fat harvested from the outer thighs, inner thighs, hips, buttocks, or arms. The highest survival rate of donor fat was noted to be from the inner knee area, as demonstrated in more than 1500 patients studied from 1984 to 1991 at Clinico Ivo Pitanguy in Rio de Janeiro. However, we have found it to be difficult to consistently harvest sufficient volumes of fat from this area because of the technical difficulties resulting from syringe liposuction and the increased risk of secondary defects.

Occasionally, it may be difficult to obtain a sufficient amount of fat from a very slender patient to perform even one procedure. In this situation, it may be prudent to suggest an alternative approach because it would not be possible to perform a second or a third treatment if necessary. From a strictly observational stand point, we have noted that fat harvested from heavier patients and patients over 55 years old produces transplant grafts that are of poor structural quality and have less long-term survival. Although younger, more slender physically fit patients have better grossly appealing fat globules that appear to survive much longer with less reabsorption.

TECHNICAL PROCEDURE

Seventy-five percent of fat transplants are performed as a primary office-based procedure under local anesthesia with oral Valium (5 mg oral and 5 mg sublingual) used as a mild sedative. As an ancillary procedure with intravenous sedation, the same technique is followed; however, the amount of local anesthesia necessary is generally less. It has been our experience that one must take great care to avoid causing pain during the first procedure, as well as diminishing postoperative swelling and ecchymosis (which is very rare). If these occur, the patient may be discouraged from following up with a second or third procedure; thus, diminishing one's chance for good long-term results that can be obtained when second and third follow-up transplants are performed.

Before beginning the procedure, the surgeon and the patient sit together to discuss their goals and concerns. It is important for the surgeon to sit in front of the patient at eye level (face to face) and take a few moments to thoroughly examine the face for general proportions, asymmetries, and predicted volumes

Figure 1. *Surgeon and patient sitting at eye level face to face discussing the patient's concerns after the markings have been completed.*

necessary to accomplish the desired results. Once this is done and the surgeon has a clear three-dimensional picture of the patient "finished" in their mind, the patient is marked and then given a mirror so they can agree with the surgeon's plan. At this point, we ask the patient to point out any additional areas of concern, which will often surprise the surgeon, when the patient notices an area of concern that was overlooked in the marking. Not paying attention to the patient's individual concerns may result in an unhappy patient, who may not appreciate any of the work performed, no matter how good the outcome (Figs. 1 and 2).

A simple setup is used, which includes a tumescent solution of 150 cc of normal saline with 30 cc of 1% xylocaine with epinephrine (1:100,000), a 3-cc syringe with straight 1% xylocaine with epinephrine, a 60-cc syringe, several 10-cc syringes, four 3-cc syringes, an 18-gauge needle, a 30-gauge needle, a #11 blade, a tumescent infiltrating canula, a fat harvesting canula, and a Newman-Brandow Fat Transplant Canula (Figs. 3 and 4).

Before beginning, the patient's abdomen is marked in a

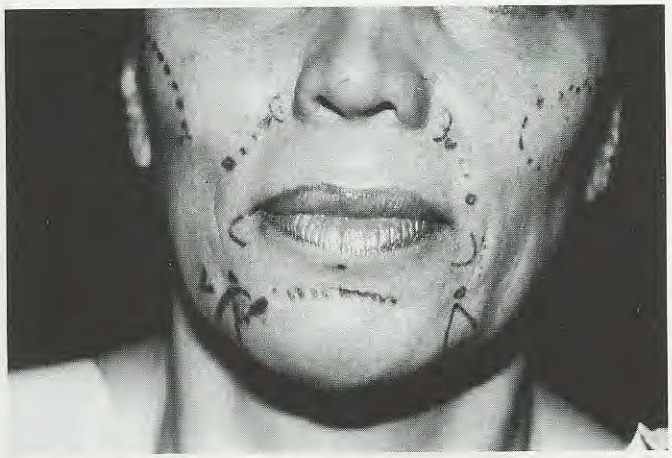


Figure 2. *Lower two-thirds of patient's face marked for augmentation of cheeks, nasolabial folds, tear drop deformities, marionette lines, and jaw line depressions.*

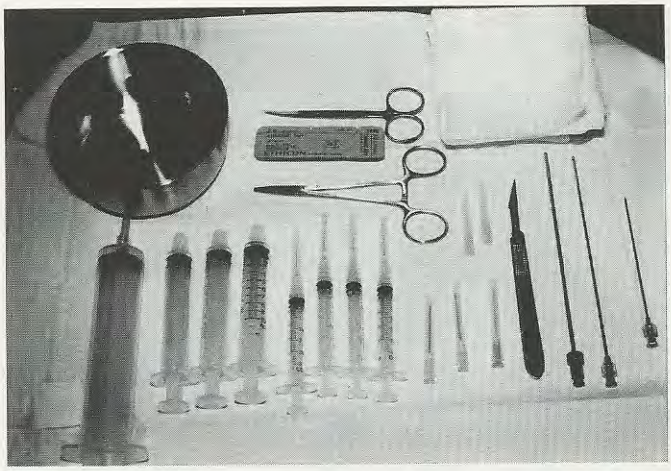


Figure 3. *Complete operative setup and instrumentation for micro lipo-augmentation.*

standing position, as if to perform a standard liposuction, with attention paid to irregularities and asymmetries. If the patient does not have sufficient lower abdominal fat, it may be necessary to utilize the outer thighs, flanks, or buttocks to obtain sufficient fat for harvesting. It is important to plan for at

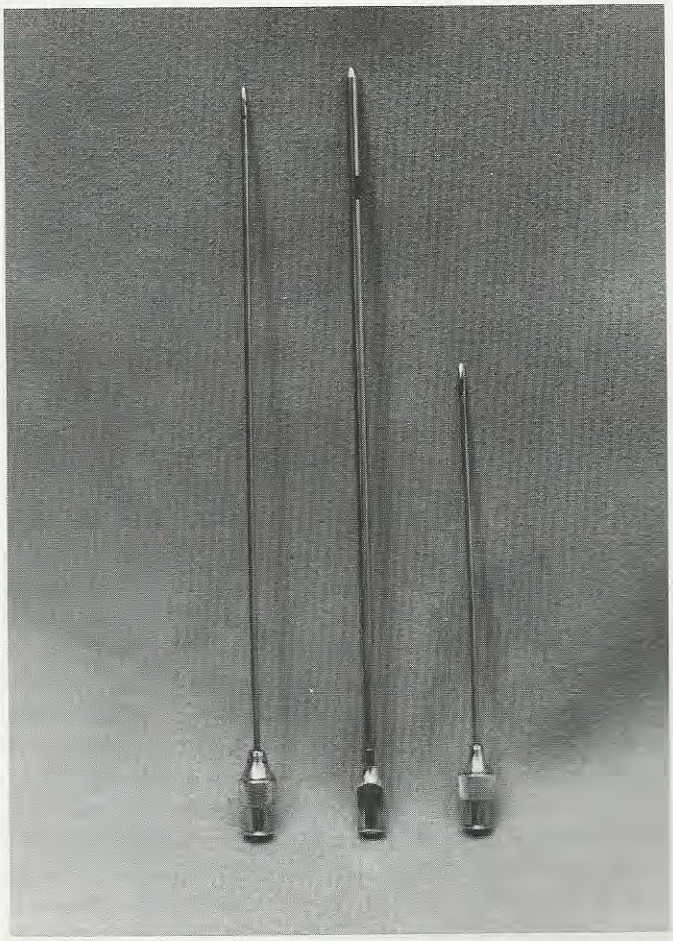


Figure 4. *Closeup of infiltrating, harvesting, and Newman-Brandow Transplantation Canulas.*

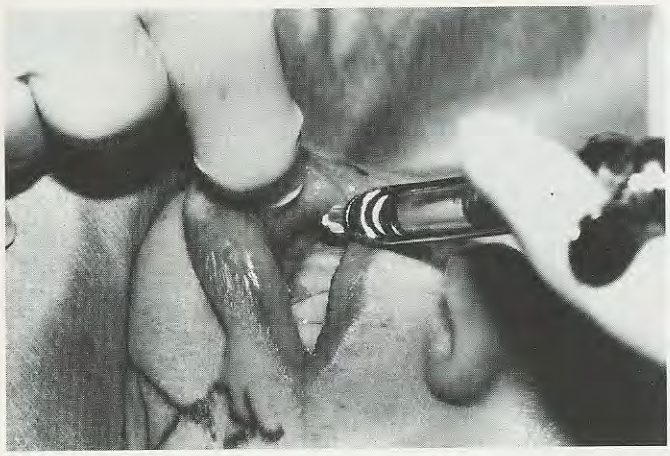


Figure 5. *Mental nerve block performed with dental syringe using 2% xylocaine with epinephrine carpules. Approximately 1 carpule (1.8 cc) is injected over each nerve for sufficient anesthesia lasting 30–45 minutes.*

least two transfers and be sure that the surgeon plans where the second and third transplants will be harvested from to avoid any liposuction asymmetries.

If the abdomen has been chosen as the harvesting site, local anesthesia is placed in a suprapubic site and a #11 blade is used to "nick" the skin. It is important to avoid using the scissors to open a tunnel because with the syringe harvesting technique one will often loose pressure in the syringe, causing multiple "stops and restarts" if a long subcutaneous tunnel is made. By using a 60-cc syringe and a 15 cm, 16-gauge infiltrating canula, the lower abdomen is tumesced symmetrically in a very slow and nonpainful fashion.

After this, the surgeon moves up to the face where topical xylocaine paste is massaged into the gum area to decrease the pain from the needle stick of the intraoral nerve blocks. After waiting several minutes for this to work, a dental syringe with 1.8 cc carpules of 2% xylocaine with epinephrine are used to perform bilateral mental and infraorbital nerve blocks by using approximately 1.8 cc on each side (Fig. 5). A common mistake made during intraoral blocks is to inject a larger quantity of the local anesthesia in the subcutaneous tissue leading up to the nerve than what is actually infiltrated over the nerve itself, thus, inadequately blocking it. A slow constant infiltration using less than one-fourth of the carpule up to the level of the nerve and then three-fourths of a carpule injected just over the nerve will usually improve the chance of an excellent block that will last throughout the duration of the procedure. The 2% xylocaine is preferred over 1% because of its increased strength and duration of action, which may be needed if one encounters difficulty in harvesting fat or the length of the procedure is prolonged.

After these blocks, the surgeon changes gloves and returns to the abdomen. Harvesting begins by suctioning with a standard 15 cm, 3-mm harvesting canula attached to a 60-cc syringe (Fig. 6). It is important to respect this part of the procedure because a rough and hasty liposuction will result in destruction of fat cells, which will have a poor or no chance of survival. It is important to keep in mind that this is a liposuction lipo-

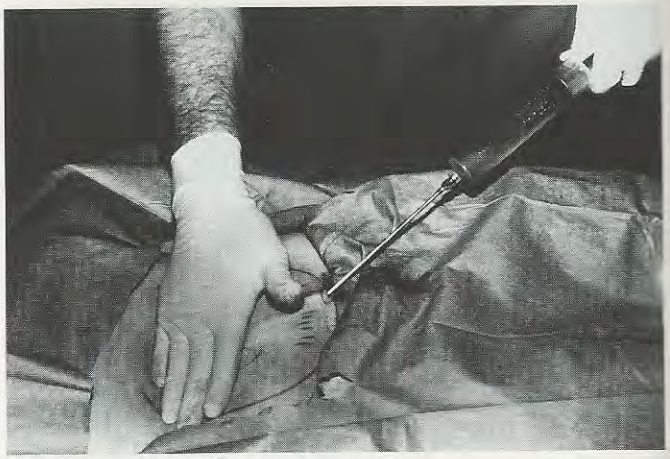


Figure 6. *Syringe liposuction of lower abdomen for harvesting of viable fat cells utilizing the tumescent technique.*

harvesting of living viable fat cells and not lipo-destruction for fat removal by liposuction. One must also take care to remove similar amounts of fat from both sides of the abdomen and be sure to look carefully at the donor site for irregularities, depressions, or deformities so as not to create a second defect to correct another. The incision is closed with a 5-0 dissolvable suture, which the patient allows to fall out within 7–10 days.

The 60-cc syringe, which should have 45–55 cc of harvested fat, is placed in a vertical position (with the tip down) and allowed to decant. The fat will rise to the top and solution to the bottom. After waiting 5–10 minutes, one notices that the separation is complete and the liquid is discarded, leaving only "pure fat" which is then transferred into 10-cc syringes (Fig. 7). Note that centrifuging will yield 15–25% more liquid, which could have been misinterpreted as transplantable fat if it had not been centrifuged (Fig. 8). Therefore, centrifuging the decanted fat will ensure a concentrated quantity of fat that can be consistently relied on to be the most accurate amount for transplantation.

Before centrifuging the fat, we had some patients return complaining of asymmetries that developed 24–48 hours after

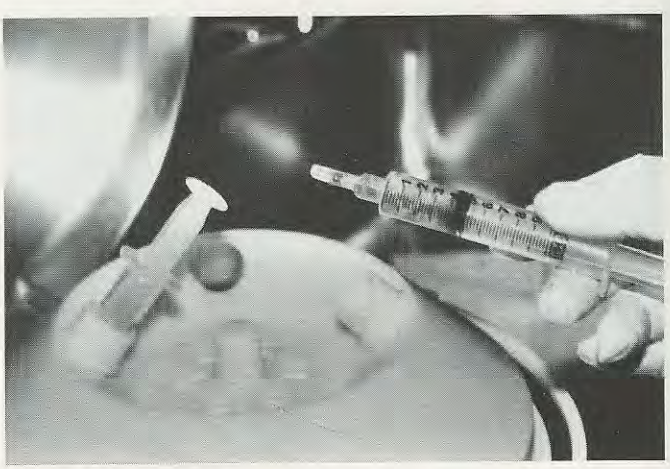


Figure 7. *Fat allowed to decant for 5–10 minutes and then cleared of excess liquid and blood showing what would appear to be "clean and pure" fat before centrifuging.*

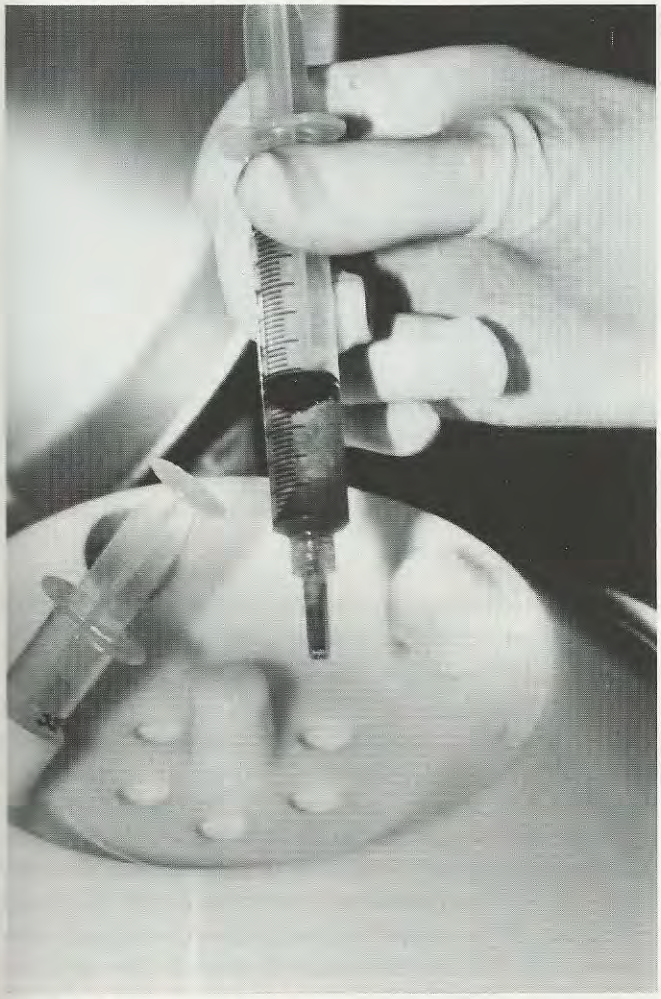


Figure 8. *Same syringe after 1 minute of centrifuge reveals a more concentrated fat graft with 25% more fluid than predicted.*

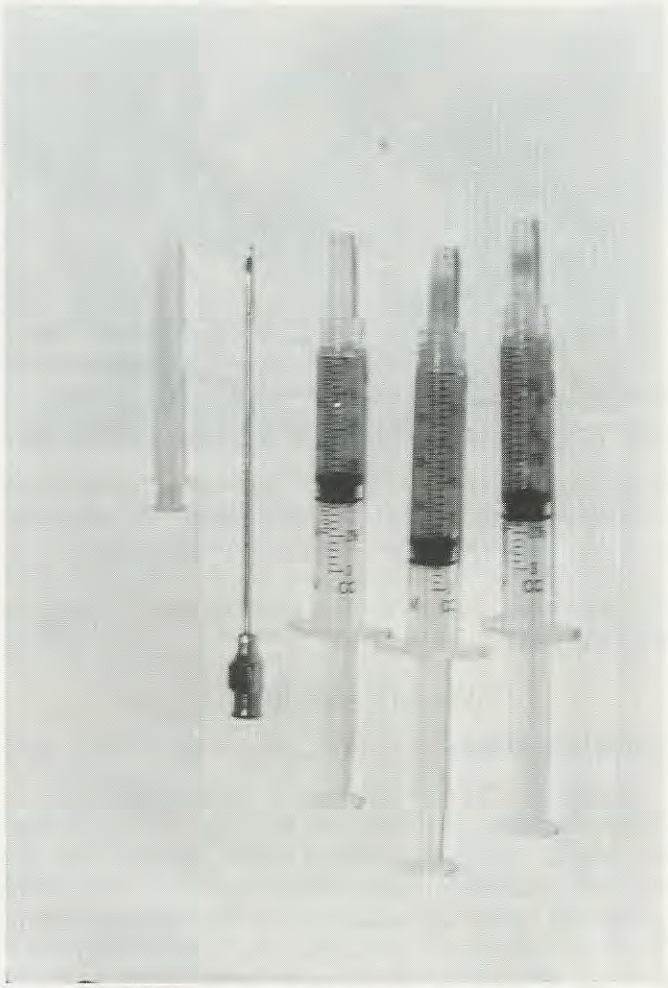


Figure 9. *Fat transplants in 3-cc syringes with blunt tip Newman-Brandow Fat Transplantation Canula.*

transplantation. We finally realized that some syringes contained larger amounts of liquid than others, which subsequently reabsorbed within 24–48 hours and left the patient with an asymmetry, which could not have been predicted when the harvested fat was only allowed to be decanted.

The centrifuged fat is then transferred from 10 cc to 3 cc Luer lock syringes and are attached to the Newman-Brandow Lipo-Transplant Canula, which is a 16-gauge, blunt tip, widened opening, fat transplant canula (Fig. 9). We believe that the 3-cc syringe gives the surgeon the best power with the most control, especially for thicker more fibrous fat grafts that may be difficult to inject through a 5 cc or 10 cc syringe. If the syringe is placed in the hand with the plunger against the thenar eminence and body between the middle and ring fingers, one will find that this position will facilitate control and accuracy during the transplant.

Five minutes before transplantation, subepidermal wheels are made at the entry sites with a 30-gauge needle and 3-cc syringe with xylocaine with epinephrine to create vasoconstriction and avoid bothersome bleeding onto the field during the procedure. Bleeding from these sites is quite disruptive and interrupts "the flow of surgery" by forcing the surgeon to change the focus of attention away from the area of transplantation to control the bleeding.

An 18-gauge needle is used to pierce a hole in the skin to make the entry site for the transplant canula. We originally used a #11 blade to make "tiny nicks" for the entry site but occasionally noted problems with minute scars, which bothered patients. By using an 18-gauge needle avoids this problem.

To facilitate atraumatic passage of the Newman-Brandow canula through the tissues, it has been found that a rotating motion, like "spinning the syringe," will avoid piercing blood vessels, injuring nerves, or causing trauma to surrounding tissues, which we have seen with "sharp" infiltrating canulas. Once the Newman-Brandow canula has reached its desired spot of transplantation, injection is performed in microdroplet amounts while the canula is being pulled backward. Great effort is made to inject less than a 3 mm in diameter tubular-shaped graft into each of these tunnels. Multiple passes are made at various levels extending from the superficial subcutaneous layer down to the muscular and submuscular layer in a fan-shaped pattern. This method of multilayered micro lipotransplantation will ensure that each grafted tunnel will have

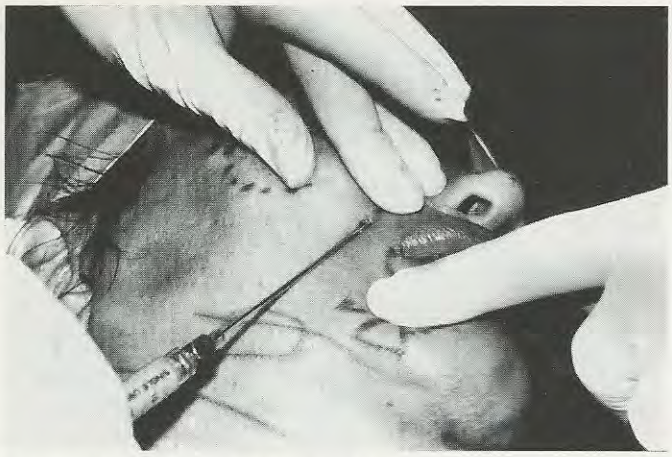


Figure 10. *Multilayered, fan-shaped lipo-transplantation along the nasolabial fold (approximately 3–4 cc on each side).*

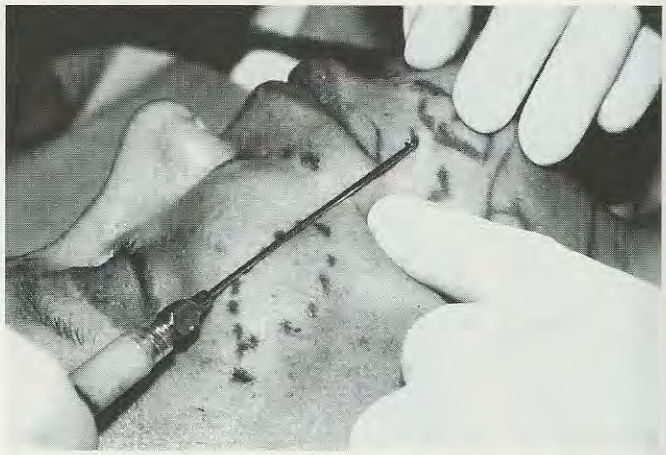


Figure 11. *Lipo-transplantation to right jaw line depression at inferior extent of marionette line (approximately 1.5–2 cc each side).*

the best chance of neovascularization while diminishing the degree of inflammation.

CAVEATS AND RESULTS

Nasal labial folds

The entry site for transplantation is usually made at the distal two-thirds of the nasal labial fold. Augmentation is performed with four to five passes, placing a total of 3–4 cc on each side (Fig. 10). A second entry site is made below the lateral alar rim (at the top of the nasolabial fold) to augment the teardrop deformity with another 1 cc of fat. Care must be taken not to augment on the lateral side of the defect, which could accentuate the fold and increase the fullness of the ptosing cheek.

Marionette lines and jaw lines

A subtle but consistent triangular-shaped depression often appears at the inferior extension of the marionette lines along the mandibular rim. To correct this, an entry site is made at the midpoint between the lateral commissure and mandibular rim (Fig. 11). Approximately 1–1.5 cc of transplant is placed in this triangular-shaped depression. Care is taken not to augment in the lateral aspect of the depression to avoid accentuation of the jowl. Transplants are "only" made in the subcutaneous layer because multilayered injections may produce trauma to the marginal mandibular nerve or facial vessels in this area.

For correction of the upper marionette lines, this same site can be used or a separate entry site can be used below the midline of the lower lip. The Newman-Brandow canula can then be rotated laterally in the subcutaneous tissue to reach the lateral commissure. Care must be taken to avoid lateral migration of fat by using the fingers of one's opposite hand to pinch the skin while injecting approximately 1–2 cc (Fig. 15).

Lower lip

An entry site is made below the vermillion border with great care taken not to nick the lip or the vermillion line, which could result in a notch-shaped deformity. The majority of the fat transplant should be placed in the middle one-third of the lower lip with less fullness created in the lateral two-thirds.

Lip enhancement can most successfully be accomplished by visualizing three multilayered planes of augmentation. The first plane lies very superficial and just underneath the vermillion border to create the "natural curl" of the lip. We generally augment this plane with less than 0.25 cc injected steadily while the canula is being pulled out. The second plane is achieved by passing the canula up and over the top of the orbicularis muscle to the level of the mucocutaneous junction and again inject approximately 0.5 cc over an even distribution. The lip is then observed for aesthetic shape and a decision is made as to the need for augmentation of the third intramuscular plane (Fig. 14). The same is repeated on the opposite side with attention given to leaving a small central depression to create a more natural looking lip.

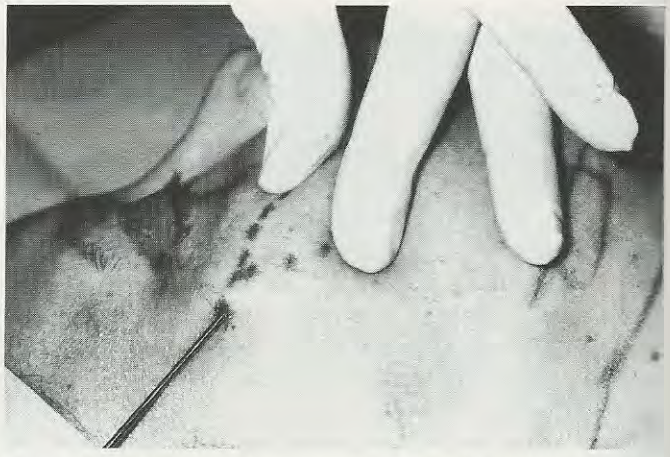


Figure 12. *Multilayered lipo-transplant to cheeks. Infiltration to deep plane can be more easily accomplished via entry at lateral alar site in superior aspect of nasolabial fold. Both sites are used for cheek augmentation (approximately 3–5 cc each side).*

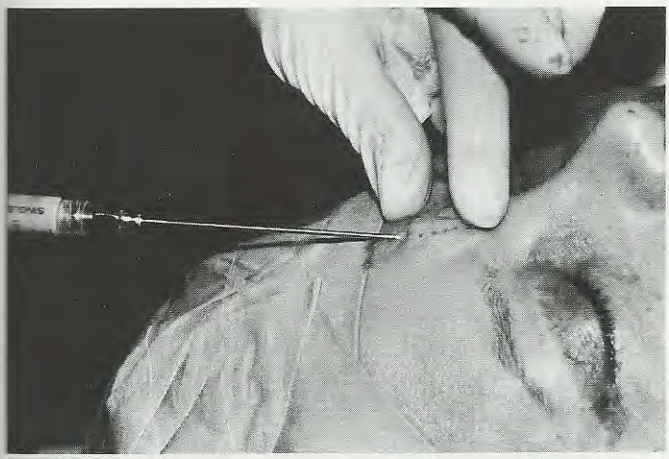


Figure 13. *Transplantation to glabellar creases. Generally, local anesthesia is used at the entry site only (approximately 1–1.5 cc).*

Upper lip

The configuration of the upper lip is different from the lower lip in that it is more elongated as laterally and fuller just under cupid's bow. Every effort should be made to maintain the natural shape of cupid's bow to avoid creating the "hotdog lip" that we see when transplants are done from one commissure to the other.

Two separate entry sites are placed above the vermillion border at the peak of each cupid's bow. Augmentation is accomplished by utilizing the identical three planes of filling as in the lower lip. If the lip begins to "flip" or "curl" and exposes more mucosa, a third level may be attempted into the muscle.

Cheeks

Depending on the deformity and the degree of fat atrophy, the cheek may be augmented by entering over the malar eminence or through the previous entry site made at the lateral nasal alar. When there is a moderate degree of medial cheek ptosis, it is better to avoid the medial approach and attempt to augment laterally. This is done in multiple layers by using 3–5 cc of fat, which is placed from the submuscular plane to the subcutaneous plane (Fig. 12). Approximately seven to eight passes may be made, placing an equal amount along a long tunnel, rather than placing a large ball of 5–6 cc in a single spot. When entering medially, one must be cautious to avoid injecting fat close to the entry site, which could make the nasal labial fold and medial cheek ptosis look worse.

Figure 14. *Lipotransfer to lower lip. Three different planes are established with approximately 0.5 cc at each level (approximately 1.5–1.5 cc on each side).*

Figure 15. *Augmentation of upper marionette line below lateral commissure. The canula is inserted through the same incision as the lower lip augmentation but completely separate tunnels are created to avoid crossover of the fat into another area. Lateral control is maintained by pinching the lateral margin of area to be augmented and injecting 0.2–0.3 cc along each tunnel (approximately 1–2 cc in each marionette line).*

Glabella and forehead creases

The glabella is difficult to anesthetize and can be quite vascular inferiorly, so caution is advised when correcting it. The patient is asked to frown and augmentation is performed in the subcutaneous layer above the procerous and corrugator muscles. The canula should not extend more inferiorly than the supraorbital rim. This can be controlled by placing a finger tightly onto the rim, passing the canula down to touch the finger and then injecting slowly as the canula is being pulled out (Fig. 13). Approximately 1–2 cc are used in most cases.

When deep forehead wrinkles are noted in patients with fat wasting in the rest of the face, multilayered lipo-augmentation can produce remarkable improvements. Approximately 6–8 cc can be transplanted throughout the entire forehead after supraorbital blocks are done.

Once the entire procedure has been completed, alcohol swabs are used to remove all of the facial markings and the patient is brought to a complete sitting position. Comparing the patient's results with their preoperative photographs will allow the surgeon to more accurately evaluate symmetry of the transplant to determine whether other small areas should be touched up before ending the procedure (Fig. 16). The patient is then allowed to look in the mirror and observe the results. Once

Figure 16. *Patient sitting up after full transplantation with all preoperative markings removed. Symmetry and fullness are checked and any touch-ups can be performed with the patient in this position to ensure equality.*

again, the surgeon may be surprised when the patient points out small areas that they feel were not adequately corrected.

Once they are happy with the result, eighth inch Steristrips are placed over the entry sites and patients are recommended to avoid putting makeup on these spots until the 7th day, so that persistent erythema will not occur if makeup were to enter into the holes before they have completely closed. Reston is placed on the liposuctioned donor site and a gauze pad is placed over the incision site to prevent the tumescent solution from leaking out during the patient's ride home. Ice-soaked gauze is placed on the lips, cheeks, and marionette lines during the first 12–24 hours and manipulation of the grafts is avoided for the first 2 weeks.

DISCUSSION

During the first documented liposuction performed in 1976, Fischer and Fischer[8] noted that defects could be corrected with transplantation of this suctioned fat. Several years later, Illouz[9,10] made some changes in the method of liposuction but was very apprehensive about the efficiency of lipotransfer. These two methods were the early liposuction techniques, which set the stage for lipo-augmentation's introduction into the armamentarium of rejuvenation. With the addition of the tumescent technique,[11] fat harvesting was simplified so that this procedure could be easily performed in the office under local anesthesia. By the late 1980s, many surgeons began transplanting fat with great enthusiasm.[12,13] However, conflicting reports of poor long-term survival rates were noted in the hands of other surgeons who discouraged the use of the technique.[5] These conflicting reports did not influence our support of fat transplantation as a useful means of facial rejuvenation. We believe that our technique attempts to incorporate important general and scientific principles that have improved our long-term survival rates.

When we began fat transplantation to the face, large volume transplantations were injected in each area (i.e., 15–20 cc in each cheek) because of the high reabsorption rates, which were thought to be in excess of 50–70%. We initially followed reports by surgeons such as Niechajev and Sevchuk[14] who documented 50% survival rates over 3.5 years after just a single fat transplantation with 50% overcorrection. Therefore, we overfilled most patients by as much as 50–70% in an attempt to get the result we believed they needed. However, this led to significant inflammation and swelling, which prevented patients from returning to work early and made them quite uncomfortable with "the look" of their new facial configuration. We also found that 9- to 12-month results were not that significant and patients were often disappointed, especially after going through the disfiguring postoperative period, which lasted 6–8 weeks.

It was not until we began correcting smaller defects and scar depressions of the face with limited amounts of fat that we clinically recognized improvements in long-term survival rates when smaller volumes (2–3 cc in each area) were used. Other surgeons also reported similar findings[15,16] from a strictly observational point of view as well. However, it was not until 1993 when the first scientifically proven clinical study on humans appeared by Carpaneda who examined 2 months (7 separate occasions) of transplanted fat into the abdominal walls of five patients undergoing abdominoplasty. He was able to histologically prove that the only viable tissue was observed in the peripheral zone of cylindrical grafts of approximately 1.5 ± 0.5 mm with a loss of 60% of the grafted tissue, which occurred closer to the center.[17,18] The following year he followed up this study, finding that the percentage of graft viability depends on the thickness and geometric shape and is inversely proportional to the graft diameter if the diameter is greater than 3 mm in size.[19,20]

From these scientifically documented clinical results we were able to support our observations that patients have an improved long-term survival of fat when multiple long tunnels are transplanted with microdroplet amounts of fat cells (less than 3 mm in diameter). Interestingly though, we have also noted marked improvement in long-term results when these transplants are repeated two to three times every 3–4 months after the initial procedure.

To investigate a reason for this finding, we histologically examined the harvested fat from 25 patients to determine whether the quality of fat was different with each successive procedure. We noted that there was a collagen surge on trichrome staining surrounding the fat globules when the fat was harvested for a second or third time (Fig. 20). We also clearly documented that centrifugation of the harvested fat did not alter the structured integrity of cell walls in unspun and spun samples (Figs. 18 and 19). This was contrary to the findings of Chajchir in 1993 who examined 40 white Swiss albino mice and found that use of a centrifuge machine at high or low speed for separating the adipose tissue components completely destroyed the adipose cells and did not allow their survival (Fig. 13). We have concluded that centrifuging the fat gives a much more consistent, purified transplant specimen.

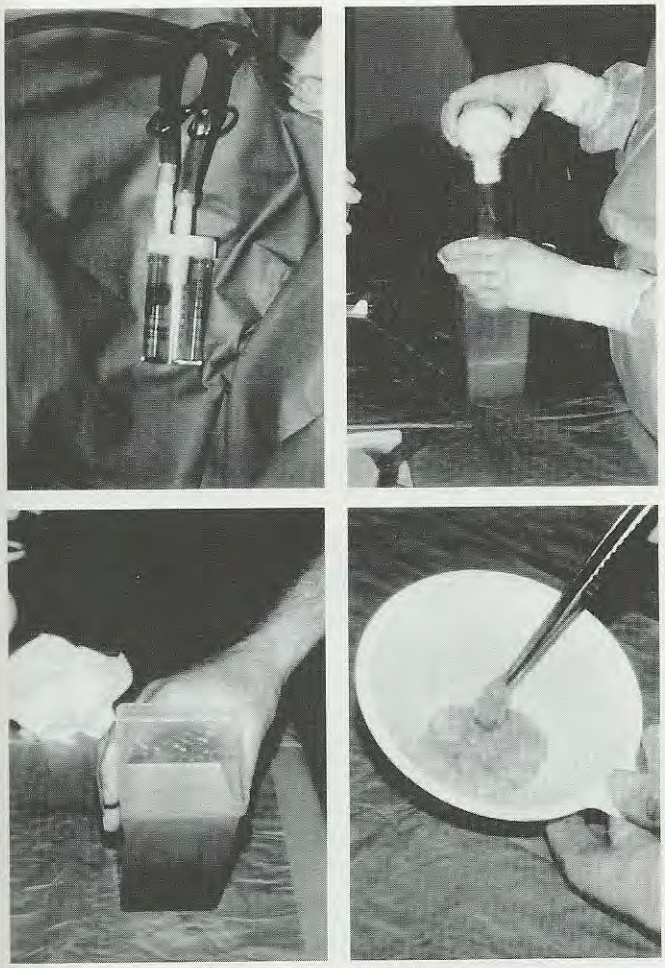


Figure 17. *Outdated fat harvesting and percument techniques. Note degree of trauma to fat cells incurred by wall suctioning of fat and mechanical washing of exposed cells.*

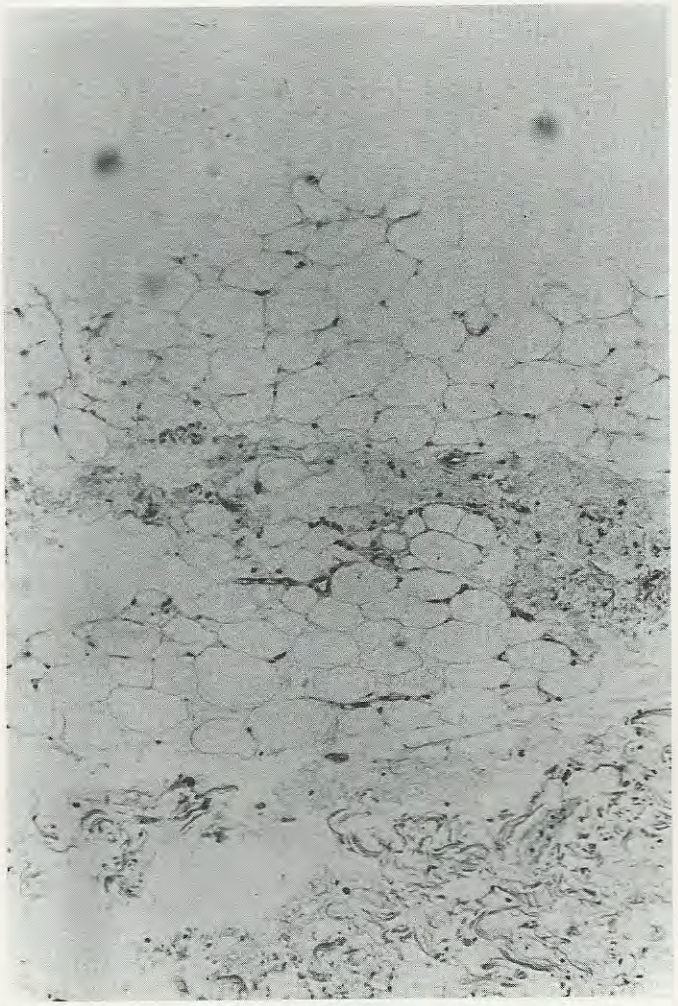


Figure 18. *Unspun fat harvested during syringe liposuction of abdomen 4 months after the first procedure.*

which we can rely on volumemetrically to accomplish the augmentation desired.

We have noted clinically that each subsequent transplantation had a cumulative effect with higher percentages of fat surviving with each successive transplant. On average, 30–40% would survive during the first transplant, 40–50% during the second transplant, and 50–60% during the third transplant. Perhaps there is a vascular stimulation factor or collagen surge at the donor site that influences the survival of the second and third fat transplants or perhaps the increased amount of collagen we noted around the fat globules after the second and third transplants made the fat cells less susceptible to the trauma of liposuction of the reinjection.

These findings parallel those of Hörl et al.[21] who examined 10 patients followed for 1 year with magnetic resonance imaging performed preoperatively at 3 months, 6 months, and 12 months postoperatively. He identified a 49% volume loss at 3 months and 55% loss at 6 months with negligible decrease in volume between 9 and 12 months. Therefore, we feel that repeating transplantations at 3–5 months would give us ample time to identify the degree of reabsorption and areas requiring reaugmentation with some degree of certainty that what remained at this point may survive over the long term of 3–5 years.

Finally, our overall results have been further improved with our development of the multilayered micro lipo-implantation technique, which places fat transplants into various tissue levels from the subcutaneous plane to the muscular and the submuscular plane in a fan-shaped pattern. The degree of inflammation is significantly less as we often small when very large quantities were placed in a single site producing inflammation and fat necrosis, which was found in grafts greater than 3 mm in diameter by Carpaneda. Supporting this clinical finding are such works as those of Nguyen et al.[22] who identified 6- and 9-month long-term survival rates, which were close to 100% in fat transplants placed in vascularized beds (rectus muscle of rabbits) versus 50% adipose loss when transplanted into low vascular areas (ear dermis of rabbits).

We believe that other factors influence the survival rate of fat that cannot be easily documented except by clinicians through their own personal observations. In our patients we have noted that the method of fat removal by using tumescent versus sharp needle suctioning does not appear to influence graft survival if

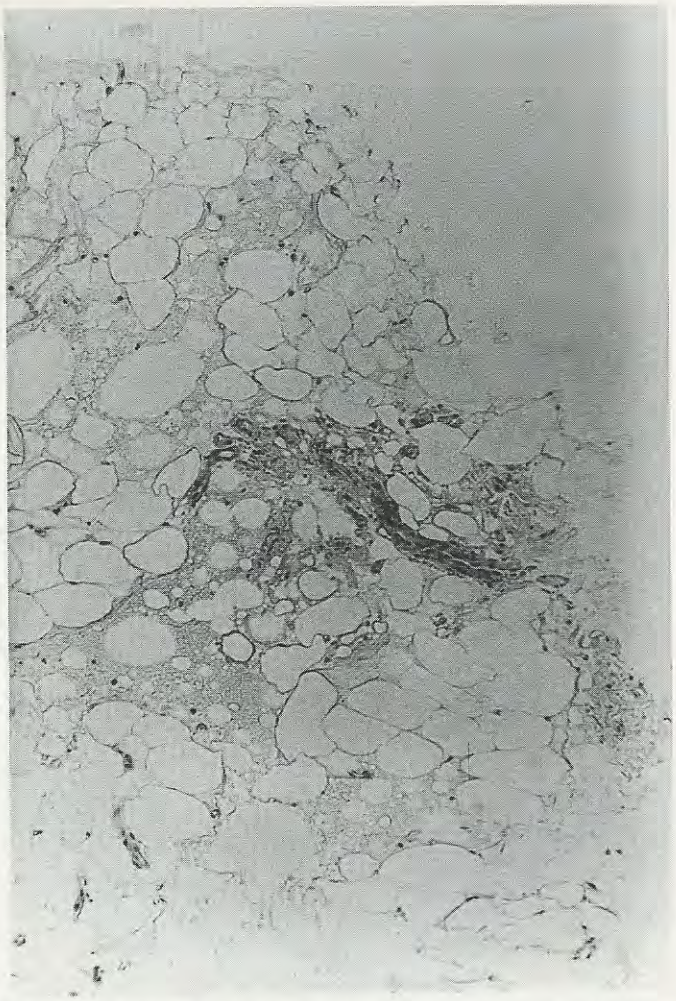


Figure 19. *Spun fat of same patient. Note architecture of adipose tissue is well preserved with a few areas of disruption, compatible with canula injury. Multiple focal areas of collagen deposition are noted.*

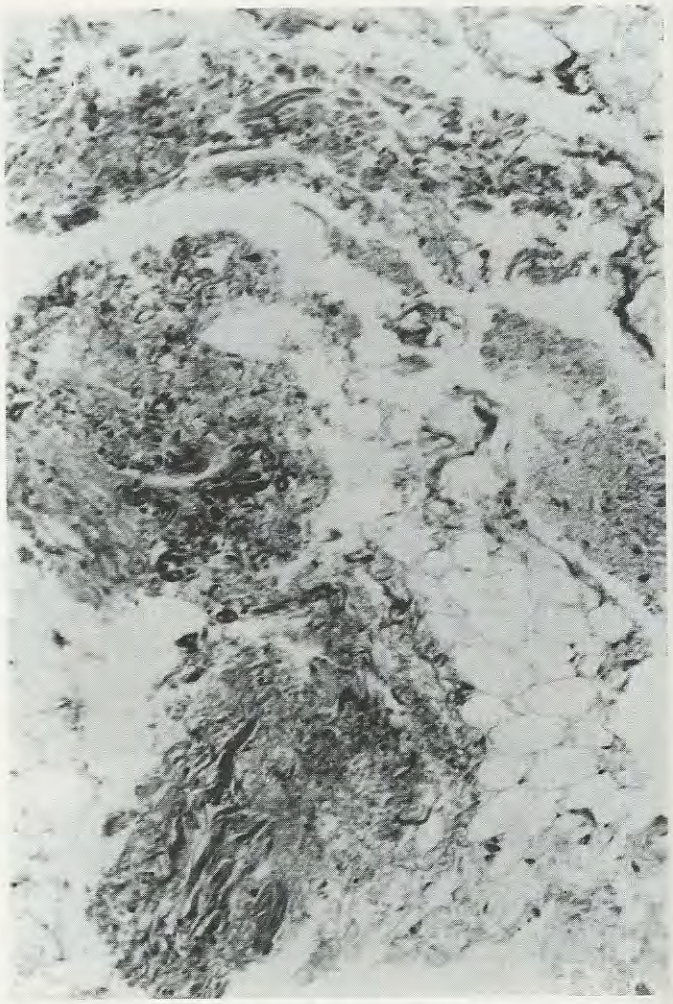


Figure 20. *High-powered trichrome staining of same patient revealing extensive areas of collagen deposition around fat cells at previously harvested liposuction site.*

the tumesced fat is centrifuged. It has been our experience that sample confusion, infection, and poor survival of fat frozen and then rethawed for future use does not improve results. We have, however, noted that the morphological size and physical fitness of the patient definitely influences the survival rate even in elderly patients. We theorize that this may be a result of smaller fat cells with higher quantities of collagen surrounding the globules, which decreases the trauma during the fat transfer and thus improves the quality of the graft once it reaches its recipient site.

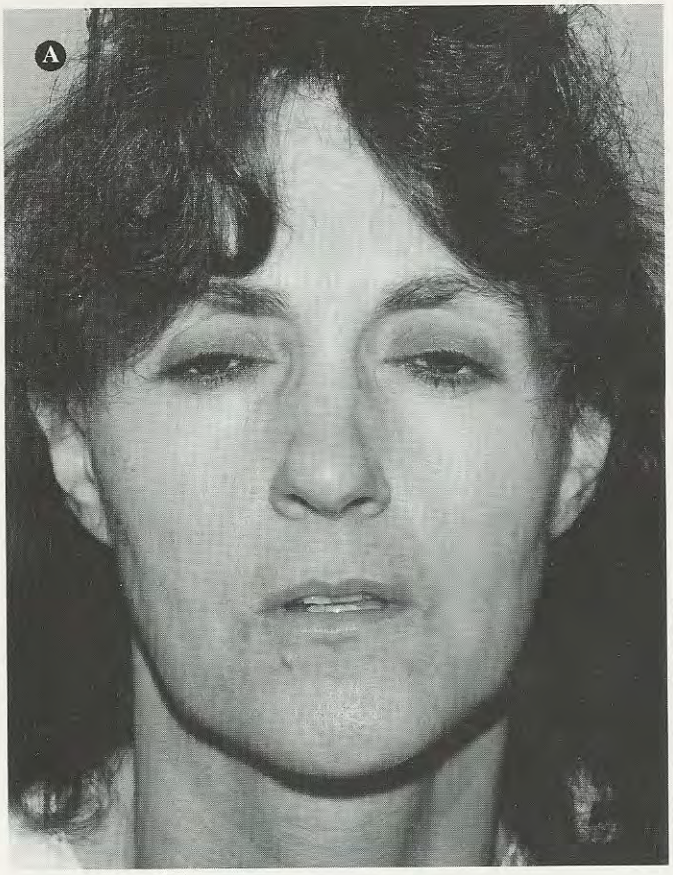
CONCLUSIONS

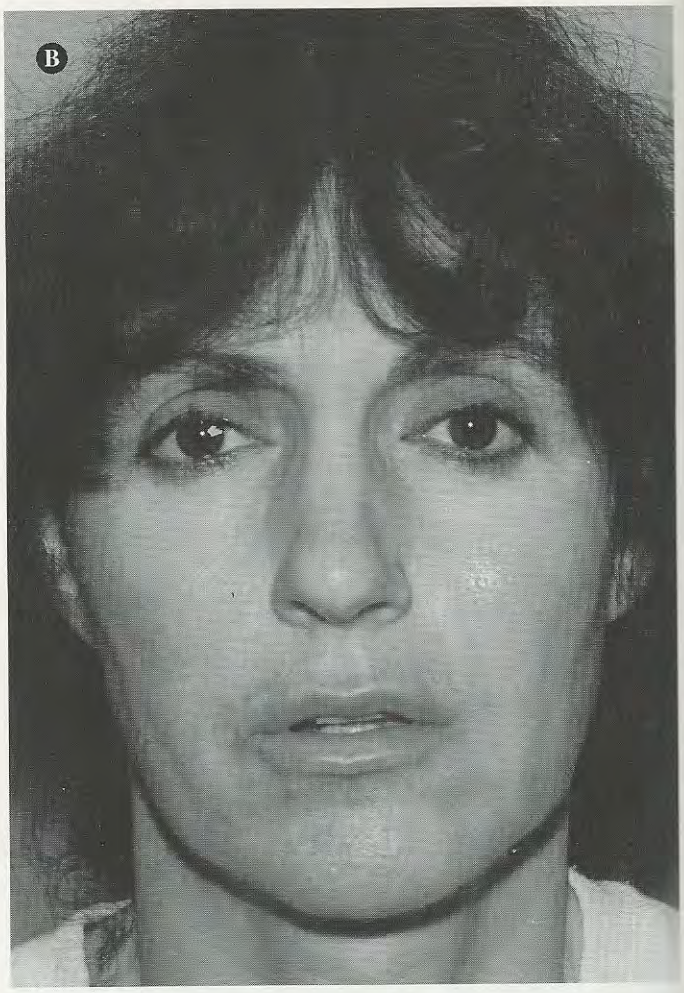
Multilayered micro lipo-transplantation is a technique that can produce very satisfying results in many different age groups without the complications and bothersome short comings of alternative procedures. Today, with so much concern regarding implantable foreign bodies there has been a resurgence of interest in fat transplantation because it has no chance of rejection, is easy to perform, and does not remove the patient from their business or social life for a long period of time. Through our experience with more than 2500 cases we have found that multiple transplantations performed at 3- to 5-month intervals (for a total of 2–3 procedures), reharvesting from the same sites with subsequent transplants, performing multilayered micro lipo-transplantation of grafts of less than 3 mm in diameter, and using finesse to perform the procedure will improve long-term results in most patients.

Perhaps we should be directing more of our attention to the use of fat transplantation and ways to improve its long-term survival by combining it with vascular stimulation factors or fibroblast growth factors[23] to improve the chance of neovascularization in the recipient site. Or perhaps preparation of the recipient site with injection of these factors into the area or preoperative needle "abrasions" performed sometime before the actual transplantation[24] will improve the blood flow and deposition of collagen to help revascularize larger volumes of fat transplanted into one area. Combining these types of ideas may help us to better understand ways to improve long-term survival rates of fat transplantation and should be the direction we take toward the future.

POSTOPERATIVE

Figure 1. *A: 34-year-old white female pre-op fat transfer to nasolabial folds, upper and lower lips, cheeks, and marionette lines. B: Follow-up 22 months fat transfer No. 1 and 18 months fat transfer No. 2.*





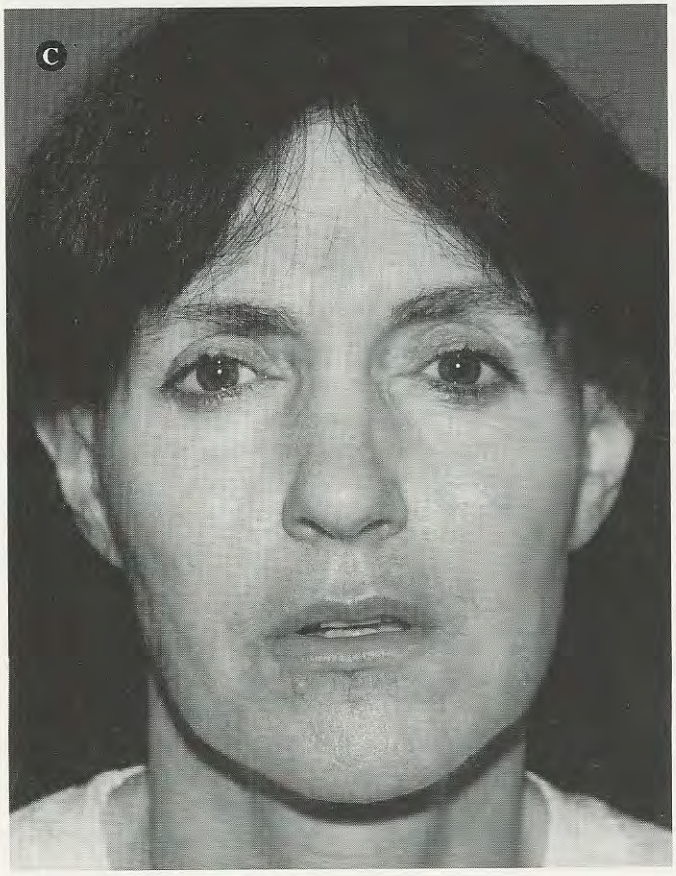


Figure 2. *A: 41-year-old white female pre-op fat transfer to nasolabial folds, upper and lower lips, cheeks, marionette lines, and jaw line. B: Follow-up 33 months fat transfer No. 1. C: Follow-up 28 months fat transfer No. 2.*

Figure 3. *A: 49-year-old white female pre-op rhinoplasty, platysmal sling, liposuction external jowls, and fat transfer to nasolabial folds, marionette lines, cheeks, and glabella. B: Follow-up 11 months fat transfer No. 1 only.*

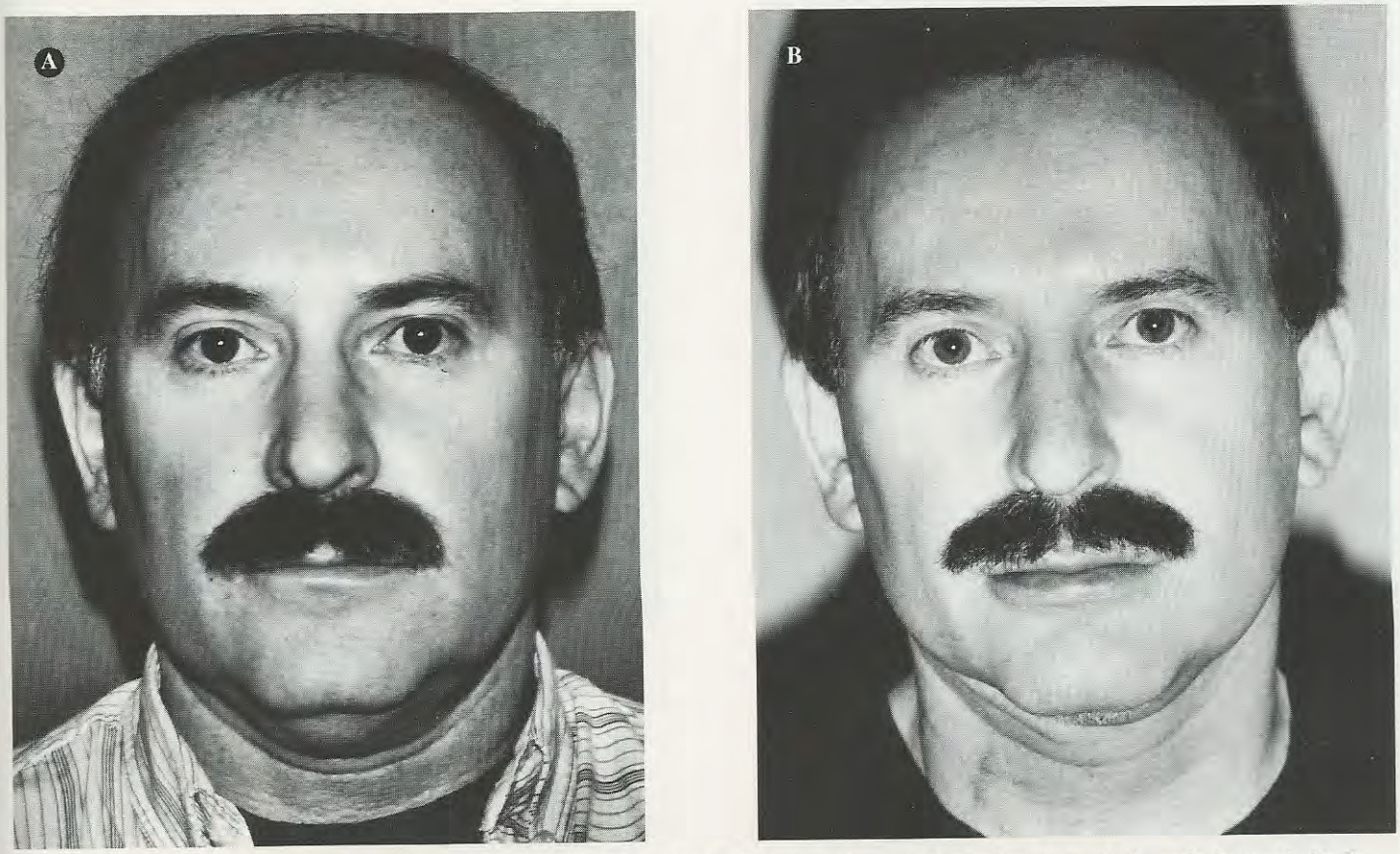


Figure 4. *A: 55-year-old white male pre-op fat transfer to upper and lower lips. B: Follow-up 16 months fat transfer No. 1 and 13 months fat transfer No. 2.*

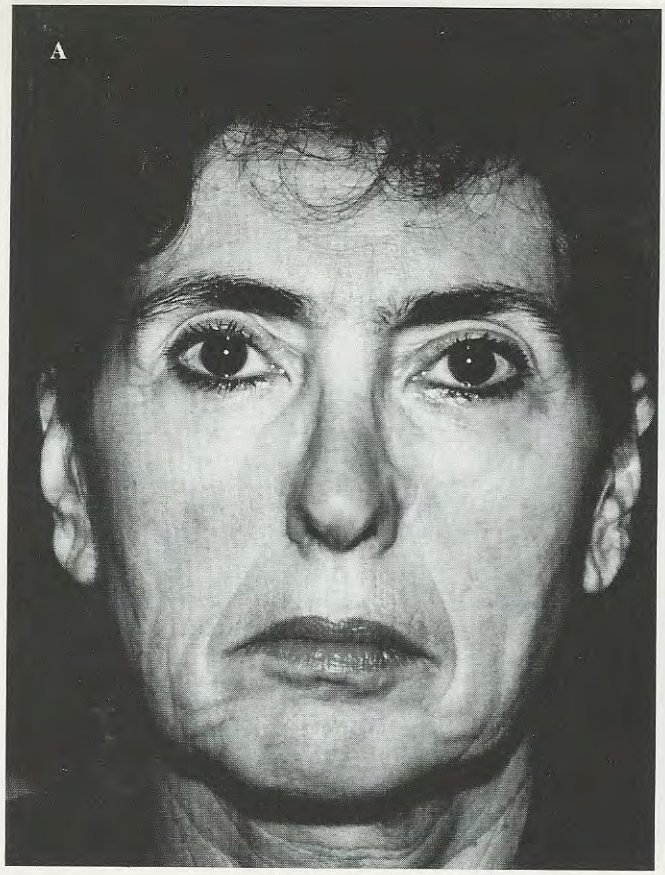


Figure 5. *A: 59-year-old white female pre-op facelift, full face phenol peel, and fat transfer to nasolabial folds, upper and lower lips, cheeks, buccal depressions, glabella, and jaw lines. B: Follow-up 36 months fat transfer No. 2.*

Figure 6. *A: 63-year-old white female pre-op fat transfer to nasolabial folds, cheeks, lips, and jaw line. B: Follow-up 8 months fat transfer No. 1.*

Figure 6. *A: Pre-op. C: Follow-up 18 months fat transfer No. 1 and 5 months upper lid blepharoplasty with lower lid and perioral CO_2 resurfacing.*

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