Journal of Cosmetic and Laser Therapy, 2011; 13: 6–12

informa
healthcare

ORIGINAL ARTICLE

Concurrent structural fat grafting and carbon dioxide laser resurfacing for perioral and lower face rejuvenation

EVAN R. RANSOM[1], MARCELO B. ANTUNES[1], JASON D. BLOOM[2] & TIMOTHY GRECO[1,3]

[1]*Department of Otorhinolaryngology—Head & Neck Surgery, University of Pennsylvania, Philadelphia, PA, USA,*
[2]*Department of Otolaryngology, New York University, Langone Medical Center, New York, NY, USA, and*
[3]*Private practice, Bala Cynwood, PA, USA*

Abstract

Objective: To quantitatively evaluate a dual-modality treatment that combines autologous structural fat grafting and carbon dioxide (CO_2) laser resurfacing for perioral and lower face rejuvenation. *Method*: Retrospective review of patients undergoing rejuvenation by a single surgeon between 2005 and 2009. A blinded expert rated photographs on three scales, each with a range of 1 (no abnormality) to 5 (severe abnormality): (i) perioral fine rhytids; (ii) deep folds; and (iii) pigmentary or cutaneous abnormalities. Within-subject comparisons were generated. Results were correlated with skin type (Fitzpatrick) and baseline photodamage (Glogau). A test for effect of adjunctive procedures was performed. *Results*: Seventeen patients were included (all female, mean age 61 years). Significant postoperative improvement was noted for perioral fine rhytids (3.1 to 1.7, $p < 0.0001$); deep folds (3.4 to 2.0, $p < 0.00001$); and pigmentation (2.5 to 1.9, $p = 0.02$). Fitzpatrick skin type was inversely correlated with improvement in pigmentation scores ($r = -0.78$), while the Glogau score correlated with improvement of fine rhytids ($r = 0.76$). No significant effect of adjunctive procedures was found. No complications occurred, though fat grafts resorbed in one patient. *Conclusions*: Concurrent structural fat grafting and CO_2 resurfacing result in quantifiable improvement of perioral and lower face aesthetics in relation to baseline characteristics and independent of adjunctive surgical procedures.

Key Words: *aging face, carbon dioxide laser, lower face, perioral, structural fat grafting*

Introduction

Perioral and lower face aging contribute significantly to the overall aesthetic changes of the aging face. Though frequently overshadowed by periorbital and malar region abnormalities, failure to adequately address the perioral region and lower face can lead to incomplete treatment and unsatisfied patients. Age-related changes in this crucial area result from actinic damage, repetitive muscle activity, descent of midface and lower face adipose tissues, and osteocutaneous ligament laxity. Thus, addressing the multifaceted aging process requires a combination of therapies to achieve complete, natural looking, and long-lasting results.

Changes in the distribution and quantity of adipose tissue in the face occur over time, with descent of the malar and jowl fat pads and relative volume loss in neighboring areas. Historically, the approach to correction of facial aging has been a variety of lifting procedures, with trimming of excess soft tissue followed by suspension. Over the past two decades, however, facial plastic surgeons have increasingly sought to correct this process with a variety of volume-enhancing modalities, including various fillers and fat grafting in different forms. Both the efficacy and durability of fat grafts for facial rejuvenation have been debated in the literature, though recent studies have supported the utility of this technique as a safe and longer-lasting alternative to temporary fillers (1–3).

In addition to restoring facial volume, the aesthetic surgeon must address the soft tissue folds

This manuscript corresponds to an oral presentation given at the AAFPRS Annual Meeting in Boston, MA, September 24, 2010.
Correspondence: Evan R. Ransom, Dept. ORL-HNS, University of Pennsylvania, 3400 Spruce St., 5th Floor Silverstein Bldg, Philadelphia, PA 19103, USA. E-mail: evan.ransom@uphs.upenn.edu

(Received 15 November 2010; accepted 26 December 2010)

ISSN 1476-4172 print/ISSN 1476-4180 online © 2011 Informa UK, Ltd.
DOI: 10.3109/14764172.2011.552615

and fine rhytids that form and deepen with age, and the accumulation of pigmentary and cutaneous abnormalities in sun-exposed skin. Traditional lifting procedures are of limited assistance with these problems as well, and frequently fail to adequately address the aging process in the medial aspect of the lower face. Many different resurfacing techniques have been studied extensively, including chemical peels in various forms, dermabrasion, and numerous ablative and non-ablative lasers. The carbon dioxide (CO_2) laser is unique among these in its proven track record, ease of control, and flexibility. This treatment modality's safety and efficacy has also been well established (4–8).

In this study, we present a combination treatment designed to address the specific issues of the lower face and perioral area. We perform concurrent structural fat grafting for volume replacement and treatment of deep folds with CO_2 laser resurfacing for perioral fine rhytids, dyschromias, and other cutaneous irregularities. In addition, we show that this dual-modality regimen is safely performed concurrently, and may be used effectively as a stand-alone treatment or in addition to open surgical procedures. Our protocol allows for effective and efficient treatment of the specific issues in the perioral area and lower face, with very minimal morbidity and down time.

Materials and methods

Patient cohort

Between 2005 and 2009, 22 patients underwent concurrent structural fat grafting and CO_2 laser resurfacing for perioral and lower face rejuvenation by a single surgeon (TG) at a single facility. Standard preoperative and postoperative photographs were taken of each patient, including frontal, oblique, and profile views, and close-ups of the perioral region. Medical charts and operative reports were reviewed in detail. Patient demographics, Glogau photoaging scores (9), and Fitzpatrick (10) skin types were recorded. In addition, details of all surgical procedures and follow-up visits were noted. Patients without complete postoperative photographs were excluded. The length of follow-up was determined as the difference in months between the preoperative and postoperative photographs.

Pre-procedure preparation

All patients were instructed to use sunscreen (SPF 45 UVA/UVB) for 4 weeks prior to the procedure and to wash their faces daily with a gentle alcohol-free exfoliating cleanser. A short course of an oral antiviral medication (acyclovir) was given for prophylaxis. Beginning 2–4 weeks before the scheduled procedure date, depending on the patient's skin type, a 4% hydroquinone cream was used twice per day. This was stopped 3 days prior to the procedure. Perioperative antibiotic prophylaxis was achieved with azithromycin (Z-Pak), starting the day prior to the procedure and continuing for 5 days in total.

Procedure and equipment

Structural fat grafts were obtained and placed in accordance with the protocol published by Coleman (11). Briefly, a Coleman bucket-handle cannula (Byron Medical, Tucson, AZ, USA) with a 10-cc Luer-Lok syringe was used for graft harvest. Raw adipose tissue was then allowed to separate into layers by removing the syringe plunger and allowing the tissue to settle for approximately 10 minutes. The remaining tissue was centrifuged for 3 minutes at 3000 RPM (IEC Medilite; Thermo Scientific, Milford, MA, USA). The lightest layer, composed primarily of oil, was wicked away using sterile cottonoids and then discarded. Fat grafts were then loaded into a 1-cc syringe with a 17-gauge Coleman type 2 cannula for placement. Linear and cross-hatching methods were used in depositing the fat grafts. Gentle digital massage of the grafted areas was then used to ensure equal distribution and adequate volume. Incisions were closed with a single, buried, 5-0 plain gut or 6-0 fast-absorbing gut suture.

Laser resurfacing was accomplished with a Coherent Ultrapulse 5000C CO_2 laser (Coherent, Santa Clara, CA, USA). Power was set at 300 mJ with a density of five and a medium spot size (pattern 38) for the initial pass. A second pass was made with a smaller spot size (pattern 32), covering slightly less surface area. A third pass was used in select cases for deeper rhytids and acne scars, particularly along the vermillion border. A fourth pass was used in two patients with significant surface irregularity, including deep scars (e.g. from acne). Care was taken to feather the beam at the margins of the treated area in all cases. This was accomplished using a lower power (250 mJ) and a smaller, triangular spot (pattern 65), particularly along the mandibular border and cervicofacial junction. In addition, in all patients with deep rhytids and soft tissue folds, the shoulder region of the rhytid or fold was traced with the CO_2 laser prior to initiation of resurfacing in that subunit as a whole.

Postoperative care

Postoperatively, all patients used a topical emollient (Aquaphor; Beiersdorf, Wilton, CT, USA) for 1 week. Patients were instructed to avoid sun exposure and to continue gentle cleansing. Dilute acetic acid soaks (one tablespoon white vinegar in eight ounces of cold water) were used for patients with excessive crusting. Standard photographs were taken at each follow-up visit.

Outcome evaluation protocol

Using the preoperative and postoperative photograph sets, an independent expert rated each patient in three categories: (i) presence and severity of deep tissue folds; (ii) presence and severity of perioral fine rhytids; and (iii) presence and severity of pigmentary anomalies (lentigines or dyschromias) and telangiectasias. In order to quantify these measures, we adapted outcome measures from previously published studies and previously validated scales (12–16). All scales were arranged from 1 to 5, with 1 being the minimal evidence of abnormality and 5 being severe or obvious abnormality. A detailed description of each scale and their values is presented in Table I.

The rating physician was blinded to all patient data and the timing (i.e. preoperative or postoperative) of the photographs presented. Photograph sets were presented together (including frontal, oblique, lateral, and close-up views), though preoperative and postoperative sets were separated and were not labeled as such for the purpose of rating. Preoperative and postoperative photograph sets from each patient were placed in a random order and shown to the rating physician. Ratings for each of the three metrics were recorded for each photograph set. In the case of the rating for deep folds, the category most appropriate for the deepest fold was used as the score (e.g. in a patient with very prominent nasolabial folds, but less prominent pre-jowl sulci, the nasolabial folds would take precedence). This process was repeated and the scores from each rating session were averaged to limit potential bias based on the order of presentation.

Statistical analyses

All statistical analyses were completed using Excel (Microsoft Corp., Redmond, WA, USA). Comparisons of preoperative and postoperative ratings were performed using within-sample Student's *t*-tests. Comparison between groups (i.e. those patients who underwent adjunctive procedures versus those who did not) was performed using independent sample Student's *t*-tests. Correlations of pre-to-postoperative differences with Glogau scores and Fitzpatrick types were performed using the correlation coefficient (r). Two-tailed analyses and a significance level of $p = 0.05$ were used in all cases.

Results

Seventeen patients were included in our analyses, while five were excluded owing to incomplete photodocumentation or loss to follow-up. All patients were Caucasian and female, with a mean age of 61 years (range 49–74 years).

The median quantity of harvested adipose tissue (pre-processing) was 50 cc (range 30–100 cc). A periumbilical donor site was used in 16 patients (94%); the remaining patient required gluteal harvest secondary to previous extensive abdominal surgery. Fourteen patients (82%) underwent structural fat grafting to the nasolabial folds (mean 3.7 cc, range 2.0–6.0 cc). Fourteen patients (82%) had fat grafts placed in the pre-jowl sulci (mean 1.4 cc, range 0.5–2.6 cc). All seventeen patients underwent fat graft placement for marionette lines (mean 2.3 cc, range 1.7–3.3 cc). All patients had CO_2 laser resurfacing to the perioral region and lower face, with the parameters described above, immediately following fat grafting. Eleven of 17 patients (64%) underwent at least one open facial rejuvenation procedure in addition to the concurrent structural fat grafting and CO_2 laser resurfacing. This included eight facelifts, six blepharoplasties, three cervical liposuctions, and one open neck lift.

No intraoperative or postoperative complications occurred. There were no hematomas or infections at the donor or recipient sites. No cases of persistent hypopigmentation, hyperpigmentation, or scar formation were noted during the study period. Structural fat grafts did not take in one patient (5.9%) who had grafts placed for marionette lines and nasolabial folds. This patient elected for revision with cross-linked hyaluronic acid fillers Restalyne (Allergan, Irvine, CA, USA) and Juvéderm (Medicis, Scottsdale, AZ, USA), rather than undergo a second fat-grafting procedure.

Table I. Outcome measures, rating scales, and detailed descriptions.

Value	Deep folds	Fine rhytids	Dyschromias
1	No visible folds, even at close examination	No visible rhytids, even at close examination	No visible pigmentary irregularity or telangiectasias
2	Mild folds, only visible upon close examination, <1 mm depth	Mild fine rhytids upon close examination	Mild pigmentary changes and lentigines, no telangiectasias
3	Moderate folds, visible with normal expression, <2 mm depth	Moderate fine rhytids, visible at a short distance	Moderate mottled hyperpigmentation, lentigines, and/or telangiectasias
4	Severe folds, prominent feature, 2–4 mm depth	Severe fine rhytids, covering less than half of the surface area, easily visible	Severely mottled hyperpigmentation, lentigines, and/or telangiectasias
5	Extreme folds, >4 mm depth, detrimental to appearance	Extreme fine rhytids, covering more than half of the surface area, detrimental to appearance	Extremely mottled hyperpigmentation, lentigines, and/or telangiectasias

Follow-up averaged 7 months, with only three patients having postoperative photographs less than 4 months from the procedure. Significant improvement was seen between preoperative and postoperative photographs in each outcome measure (summarized in Table II). Preoperative deep fold scores averaged 3.4, while postoperative scores averaged 2.0. Within-subject comparison confirmed significant improvement ($p < 0.00001$). Preoperative fine rhytid scores averaged 3.1, while postoperative scores averaged 1.7. Within-subject comparison confirmed significant improvement ($p < 0.0001$). Preoperative pigmentation scores averaged 2.5, while postoperative scores averaged 1.9. Within-subject comparison confirmed significant improvement ($p = 0.02$).

Improvement across each outcome measure was found to be independent of the performance of adjunctive open procedures ($p = 0.7$ for deep folds; $p = 0.1$ for fine rhytids; and $p = 0.4$ for pigmentary dyschromias). Improvements in fine rhytid scores were positively correlated with Glogau scores ($r = 0.76$), such that patients with greater baseline photodamage showed relatively greater improvement on the fine rhytid scale. Improvements in pigmentation scores were negatively correlated with Fitzpatrick skin types ($r = -0.78$), such that patients with fairer skin tone showed relatively greater improvement on the pigmentary dyschromia scale. Improvements in deep fold scores were not strongly correlated with either baseline Glogau scores or Fitzpatrick skin types.

Figures 1 and 2 illustrate the typical results of our concurrent procedures. Figure 1 shows a 74-year-old woman preoperatively and at 8 months' follow-up. This patient had structural fat grafts to the nasolabial folds, marionette lines, and pre-jowl sulci. She did not undergo adjunctive open procedures. Figure 2 shows a 63-year-old woman preoperatively and at 10 months' follow-up. This patient had structural fat grafts to the nasolabial folds and marionette lines, and also underwent a short-flap rhytidectomy with SMAS plication.

Figure 1. Preoperative (A) and 8-month postoperative (B) photographs of a patient who underwent concurrent structural fat grafting to the nasolabial folds, marionette lines, and pre-jowl sulci with CO_2 laser resurfacing. No adjunctive open procedures were performed.

Discussion

The origins of structural fat grafting are found as far back as the late 19th century, when the utility of tissue volume replacement was first demonstrated. This technique was rediscovered in the mid-20th century, though initial enthusiasm was tempered by reports of fat graft resorption and disappointing results (17,18). Over the last two decades, a better understanding of free fat graft survival and improved techniques for harvesting autologous fat have dramatically boosted the interest in this soft tissue filler (1,2,19). The most popular method used today is that described by Coleman, which we have employed in this study (1,11). The durability of structural fat grafts, however, remains a matter of debate. Some authors claim excellent long-term results (1), which are considered to be persistence of the desired fullness effect for at least 12 months. Others report

Table II. Summary of results.

	Fine rhytids	Deep folds	Pigmentation
Preoperative mean	3.1	3.4	2.5
Postoperative mean	1.7	2.0	1.9
Mean difference	1.4	1.4	0.6
p-value*	$p < 0.0001$	$p < 0.00001$	$p < 0.02$

All scales ranged from 1 to 5, with increasing numbers corresponding to greater severity.
*The *p*-values are for within-subject comparisons.

Figure 2. Preoperative (A) and 10-month postoperative (B) photographs of a patient who underwent concurrent structural fat grafting to the nasolabial folds and marionette lines with CO_2 laser resurfacing. This patient also underwent a short-flap rhytidectomy with SMAS plication.

good to fair or even poor results (2,20). The recipient site has also proved to have an effect on aesthetic outcome, with the malar, cheek, and chin showing better results than nasolabial folds and marionette lines, which are, in turn, better than forehead, brow, nose, the temporal region and the lips (3).

In addition to volume restoration, modern facial rejuvenation must attend to surface abnormalities. Carbon dioxide (CO_2) laser resurfacing works by vaporization of water molecules, causing thermal damage which then stimulates fibroblasts to increase collagen production and eventually replenish the overlying epidermis. This modality allows more precise treatment of facial rhytids than dermabrasion or facial peels, and has been widely used for about two decades. Long-term improvement in facial rhytids following CO_2 laser treatment is well-documented (4–7,21). Complications include milia, acne flares, cellulitis, pigmentary changes, and rarely scarring. Even though overall complication rates (major and minor) exceeding 50% have been reported (8), these are usually self-limited with only a small minority presenting problems after 12 months. The most common of these is persistent hypopigmentation, which was present in 13% of patients in the large series by Ward and Baker (8).

In our study, we employed the first reported combined, concurrent treatment of the perioral region and lower face with structural fat grafting and CO_2 laser resurfacing. Using a blinded rater and standardized scales, we have shown significant and quantifiable improvement in three aesthetic domains: perioral fine rhytids, deep tissue folds of the middle and lower face, and pigmentary abnormalities of the perioral and lower face regions. Further, aesthetic improvements were found to be independent of adjunctive open surgical procedures. We also report an extremely low combined complication and revision rate (about 6%). Finally, no negative effects of concurrent treatment were observed, and our fat graft take rate was very high (about 94%), even after months of follow-up.

The results of our study are difficult to compare with the others available in the literature, given that the available studies use a single treatment modality, and, to the authors' knowledge, there are no previous reports of concurrent structural fat grafting and CO_2 laser resurfacing. It has been reported in the literature that the results of fat grafting in the perioral region are inferior to other areas, particularly the infraorbital rim (3). Though our study does not directly compare perioral and periocular fat grafting results, we find no evidence for poor aesthetic results in the perioral region. In addition, some authors have cautioned that CO_2 laser resurfacing is less effective in the lower face than in other facial subunits (8), while others have shown excellent results throughout the face (8) and in the upper lip specifically (5). Similarly, we did not directly compare resurfacing results between regions, but we find no evidence for inferior aesthetic outcomes in the perioral region and lower face. The senior author attributes this fact to two specific techniques: first, all deeper rhytids and folds are 'outlined' with the CO_2 laser along the shoulder region prior to treatment of the subunit as a whole; and second, a meticulous feathering protocol, with lower power and a smaller spot size, is employed during treatment of the mandibular border.

Our follow-up period ranged from 2 to 17 months, with only three patients being evaluated before 4 months. The average time for stabilization of the fat graft would be around 3–4 months (3,20), when

most of the fat that will be absorbed would have done so. Therefore, even though our cohort follow-up could be considered short, we feel that the patients who have a clear benefit after 4 months will continue to demonstrate enhanced tissue volume for a longer period of at least 12 months (11).

Concomitant fat grafting and laser resurfacing is possible and safe. No cases of significant and lasting hypopigmentation or hyperpigmentation were present at follow-up evaluation, though a transient hypopigmentation was expected and observed in a majority of patients. It is well-known—and indeed somewhat beneficial—that pigmentation changes are a common effect of CO_2 laser resurfacing, with hyperpigmentation being more common in patients with darker skin, and usually being self-limited, and hypopigmentation which tends to be permanent at least to some degree (8,22,23). Moreover, we demonstrate here that no additional morbidity is expected when structural fat grafting and CO_2 laser resurfacing are performed concurrently. The benefits, on the other hand, may be additive, and our patients have shown significant improvements which were independent of adjunctive open surgical procedures. It is important to note, though, that these tools do not replace or preclude traditional surgical treatment of the aging face. Rather, our combined treatment can be safely used as an adjunct or as a first step before more invasive treatments.

The authors believe that multi-modality facial rejuvenation achieves the best results. Adding a 'third dimension' to facial rejuvenation with permanent volume replacement and skin resurfacing, allows the facial plastic surgeon to overcome the limitations of traditional lifting and trimming procedures. While rhytidectomy addresses skin laxity and lateral excess, a potential pitfall is the overemphasis on the neck and jaw line, with concomitant failure to completely address midline areas. In addition, lifting a priori cannot treat volume loss or surface abnormalities, which are crucial to the rejuvenation of the perioral area and lower face. For volume restoration, a number of soft tissue fillers are available, though these give only temporary results and require repeated treatments. In addition, some authors have argued that fat is the ideal filler, and may even possess a biologically based restorative capacity for the overlying skin (1). Autologous fat is biocompatible, lacks toxicity, and has a low cost and a very low incidence of complications. For the residual surface irregularity, pigmentation issues, and telangiectasias, the CO_2 laser is a well-established and familiar treatment modality. As we have shown here, this tool has the additional benefit of compatibility with concurrent fat grafting.

Conclusions

Concurrent structural fat grafting of the perioral area and lower face with CO_2 laser resurfacing results in significant improvement in contour, texture, and pigmentation. We observed a reduction in perioral fine rhytids and pigmentary dyschromias, in addition to long-lasting improvement in the nasolabial folds, marionette lines, and pre-jowl sulci. This treatment is safe, has a very low revision rate, and offers the facial plastic surgeon an excellent stand-alone procedure or adjuvant treatment for aging face patients.

Acknowledgement

Dr Greco is on the Speakers Bureau for Allergan and Medicis.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

1. Coleman SR. Structural fat grafting: More than a permanent filler. Plast Reconstr Surg. 2006;118(3 suppl):108S–20S.
2. Kaufman MR, Bradley JP, Dickinson B, Heller JB, Wasson K, O'Hara C, et al. Autologous fat transfer national consensus survey: Trends in techniques for harvest, preparation, and application, and perception of short- and long-term results. Plast Reconstr Surg. 2007;119:323–31.
3. Mojallal A, Shipkov C, Braye F, Breton P, Foyatier JL. Influence of the recipient site on the outcomes of fat grafting in facial reconstructive surgery. Plast Reconstr Surg. 2009; 124:471–82.
4. Bisson MA, Grover R, Grobbelaar AO. Long-term results of facial rejuvenation with carbon dioxide laser resurfacing using a quantitative method of assessment. Br J Plast Surg. 2002;55(8):652–6.
5. Dijkema SJ, van der Lei B. Long-term results of upper lips treated for rhytids with carbon dioxide laser. Plast Reconstr Surg. 2005;115(6):1731–5.
6. Manuskiatti W, Fitzpatrick RE, Goldman MP. Long-term effectiveness and side effects of carbon dioxide laser resurfacing for photoaged facial skin. J Am Acad Dermatol. 1999; 40(3):401–11.
7. Schwartz RJ, Burns AJ, Rohrich RJ, Barton FE Jr, Byrd HS. Long-term assessment of CO_2 laser resurfacing: Aesthetic results and complications. Plast Reconstr Surg. 1999;103(2): 592–601.
8. Ward PD, Baker SR. Long-term results of carbon dioxide laser resurfacing of the face. Arch Facial Plast Surg. 2008; 10(4):238–43.
9. Glogau RG. Aesthetic and anatomic analysis of aging skin. Semin Cutan Med Surg. 1996;15(3):134–8.
10. Fitzpatrick TB. The validity and practicality of sun-reactive skin types I through VI. Arch Dermatol. 1988;124(6): 869–71.
11. Coleman SR. Hand rejuvenation with structural fat grafting. Plast Reconstr Surg. 2002;110(7):1731–44.
12. Alexiades-Armenakis M. Rhytids, laxity, and photoaging treated with a combination radiofrequency diode laser and

pulsed light, and assessed with a comprehensive grading scale. J Drugs Dermatol. 2006;5(8):731–8.
13. Day DJ, Littler CM, Swift RW, Gottlieb S. The wrinkle severity rating scale. Am J Clin Dermatol. 2004;5(1):49–52.
14. Lemperle G, Holmes RE, Cohen SR, Lemperle SM. A classification of facial wrinkles. Plast Reconstr Surg. 2001;108: 1735–50.
15. Lowe N, Horowitz S, Tanghetti E, Draelos Z, Menter A. Tazarotene versus tazarotene plus hydroquinone in the treatment of photodamaged facial skin: A multicenter, double-blind, randomized study. J Cosmet Laser Ther. 2006;8: 121–7.
16. Shoshani D, Markovitz E, Monstrey SJ, Narins DJ. The modified Fitzpatrick wrinkle scale: A clinical validated measurement tool for nasolabial wrinkle severity assessment. Dermatol Surg. 2008;34:S85–91.
17. Ersek RA. Transplantation of purified autologous fat: A 3-year follow-up is disappointing. Plast Reconstr Surg. 1991;87(2): 219–27.
18. Peer LA. The neglected free fat graft. Plast Reconstr Surg. 1956;18(4):233–50.
19. Sommer B, Sattler G. Current concepts of fat graft survival: Histology of aspirated adipose tissue and review of the literature. Dermatol Surg. 2000;26:1159–66.
20. Eremia S, Newman N. Long-term follow-up after autologous fat grafting: Analysis of results from 116 patients followed at least 12 months after receiving the last of a minimum of two treatments. Dermatol Surg. 2000;26:1150–8.
21. Kitzmiller WJ, Visscher M, Page DA, Wicket RR, Kitzmiller KW, Singer LJ. A controlled evaluation of dermabrasion versus CO_2 laser resurfacing for the treatment of perioral wrinkles. Plast Reconstr Surg. 2000;106(6):1366–72.
22. Apfeiberg DB. Side effects, sequelae, and complications of carbon dioxide laser resurfacing. Aesthet Surg J. 1997;17(6): 365–72.
23. Nanni CA, Alster TS. Complications of carbon dioxide laser resurfacing. An evaluation of 500 patients. Dermatol Surg. 1998;24(3):315–20.