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Esthetic and cosmetic dermatology

UWE WOLLINA*, ALBERTO GOLDMAN†, UWE BERGER‡ & MOHAMMED BADAWY ABDEL-NASER§

**Department of Dermatology and Allergology, Hospital Dresden-Friedrichstadt, Dresden, Germany, †Clinica Goldman of Plastic Surgery, Porto Alegre, RS, Brazil, ‡Kieferchirurgische Gemeinschaftspraxis, Chemnitz, Germany, §Department of Dermatology and Venereology, Ain Shams University Hospital, Cairo, Egypt*

ABSTRACT: The field of esthetic and cosmetic dermatology has gained remarkable interest all over the world. The major advantage of recent years is the high scientific levels of the most significant new developments in techniques and pharmacotherapy and other nonsurgical approaches. The present paper reviews selected fields of interest under this view. Sexual hormones are involved in the aging process of men and women. Skin function, in particular the epidermal barrier, is affected by a loss of endocrine activity. Hormone replacement therapy has only recently been introduced in treatment of aging males. This is an area of gender-medicine in dermatology with a strong well-aging attempt. Botulinum toxin therapy for hyperfunctional lines has become not only well-established but evidence-based medicine on its highest level. Recent advantages were gained in objective evaluation and monitoring the effect. Digital imaging techniques with various facets have been introduced to assess the achievements of treatment in the most objective way. This may become an example for other techniques as peeling, laser therapy, or radiofrequency in esthetic and cosmetic dermatology. Botulinum toxin has become a valuable tool for brow lifts. Details of the technique are discussed. Cellulite is a strongly female gender-related condition. During the past decades numerous treatments had been recommended but only recently a more critical scientific approach led to improvements in therapy of this common and disfiguring condition. Three major approaches are developed: (a) skin loosing with techniques such as subcision, (b) skin tightening with radiofrequency and other approaches, and (c) improving circulation in blood and lymphatic microvasculature using both physical treatments and pharmacotherapy. The last two chapters are devoted to body sculpturing by lipotransfer and lipolysis. Lipotransfer for facial or body sculpturing has a history of about 100 years. Nevertheless, recently the role of adult stem cells in adipose tissue has gained much interest. By optimizing the harvesting, storage, and transplantation of adipose tissue, remarkable long-standing results have been obtained. Here the present authors will focus on midface contouring, where lipotransfer competes with dermal fillers. Lipolysis is another effective tool in body sculpturing. The present authors will focus on recent advances in laser-assisted lipolysis for delicate body sculpturing in the submental region but also for gynecomastia abdominal region, flanks, and hips. In conclusion, esthetic and cosmetic dermatology has become a scientific-based subspeciality of dermatology with evidence-based treatments and a great variety of high-tech approaches to provide more effective, more selective, and safer therapeutic options.

KEYWORDS: adult stem cells, aging males, botulinum toxin, cellulite, hormone replacement, laser-assisted lipolysis, lipotransfer

Address correspondence and reprint requests to: Uwe Wollina, MD, Department of Dermatology and Allergology, Hospital Dresden-Friedrichstadt, Academic Teaching Hospital of the Technical University of Dresden, Friedrichstrasse 41, 01067 Dresden, Germany, or email: wollina-uw@khdf.de.

Esthetic and cosmetic dermatology (ECD) has gained a broad interest as never before in all parts of the world. Sometimes the critics of such development complain that dermatology as a medical discipline might shrink to an unimportant niche of academic beauticians. Albeit, there is always a risk of misleading developments, of false and wrong reality shows that ECD indeed has matured to a scientific discipline with strong connections to basic and applied sciences and an attempt of preventive medicine in a much broader sense than traditionally anticipated. In the following chapter the present authors will discuss selected new developments on ECD.

Androgens and aging

Although aging is an inevitable biologic process that can be linked to a variety of pathologies like degenerative disorders, cancer, and skin diseases, aging itself is a physiologic process and not a disease.

Several attempts have been made to ensure the physiologic nature of well aging and prevent the negative impact on health and quality of life. The detection of endocrine-senescence has raised the hope that hormone replacement might be a way to slow down the aging process and support well-being. This part of ECD has a direct link to geriatric medicine and prevention of cancer.

In this chapter the present authors will focus on the aging male. The aging process associated with secondary hypogonadism is known as andropause. It is characterized by multiple clinical symptoms including osteoporosis, loss of muscle strength, loss of reproductive function and hypogonadism, thyroid dysfunction, fat accumulation, disturbance of sleep, and tendency to the development of cancer and infections. From the ECD point of view, alterations in body hair and skin are of interest.

During fetal life testosterone retards epidermal barrier function, but data on adult or aging skin are missing (1). Androgen receptors (AR) are strongly expressed in skin by sebocytes, eccrine, and apocrine sweat glands (2). In eccrine and apocrine sweat glands luminal cells of the secretory portion are variably AR reactive (3). In male mice gonadectomy leads to a diminution of the AR expression by sebaceous glands (4).

Androgen receptors are expressed by the secretory epithelium of axillary apocrine glands in correlation to their secretory activity (5). In patients with nonautoimmune dry eyes with Meibomian gland dysfunction, the level of bioavailable testosterone is significantly reduced (6).

Typical cutaneous signs of andropause are loss of hairs in ear and nose, a decrease in body hair, and thinning of skin (7). In particular the light-protected skin becomes thinner with age, and sebum production decreases which may lead to irritability and asteatotic eczema (8). Interestingly, human keratinocytes obtained from aged people show an enhanced androgen sensitivity (1).

Melanocytes express AR and 5-alpha-reductase type 1, which explains the diminished pigmentation of penis and scrotal skin in hypogonadal males. Sun exposition causes less tanning but pale skin of hypogonadal men is also caused by reduced blood circulation and erythropoiesis (9).

Testosterone replacement therapy is an opportunity to normalize physiological functions after careful evaluation of the potential risks and benefits. The major domains of health risks are prostate, cardiovascular system, erythropoiesis, and lipid profile. Whereas breast cancer, polyglobulia, and untreated sleep apnea are absolute contraindications, coronary artery disease in men seems to be associated with low testosterone (10). The longstanding concern that testosterone replacement therapy may increase the risk of prostate cancer has come under new scrutiny. New evidence suggests that TRT has little, if any, negative impact on the prostate, even in men with a history of prostate cancer (11). In a few studies men who underwent radical prostatectomy have been treated with testosterone replacement without any biochemical recurrences (12).

In studies including men above the age of 50, testosterone replacement has led to an increase in lean body mass (1–3 kg), decrease in fat mass (0–2%), increase in muscular strength and bone mineral density, decline of total cholesterol and normalization of sexual dysfunction, improvement of cognitive function, and mood disturbances (13–18; Table 1). The impact on skin aging, however, has not been studied systematically yet. Patients on testosterone replacement need a regular follow-up with urological investigation and serum PSA (19).

Botulinum toxin A

Botulinum toxin A (BTXA) has come of age in ECD. It has been proved to be an effective and safe treatment for hyperfunctional facial lines. The best evidence has been obtained for the upper face, i.e., glabelar and frown lines and

Table 1. Testosterone replacement therapy in aging males

Study	Design	Subjects	Treatment	Outcome
Tenover 1992	T vs. placebo	*n* = 13, 57–76 years, T < 14 nmol/L	T enanthate im 100 mg weekly or placebo for 3 months	Gain in lean mass
Sih et al. 1997	RCT	*n* = 32, 51–69 years, T < 16.7 nmol/L	T cypionate im 200 mg every 2nd week or placebo for 12 months	Increase in grip strength
Snyder et al. 1999	RCT	*n* = 108, > 69 years, T < 16.5 nml/L	Testoderm scrotal patch 6 mg or placebo for 3 years	Increase in lean mass, decrease in fat mass
Kenny et al. 2002	RCT	*n* = 67, 72–80 years, T < 4.4 nmol/L	T patch 2–2.5 mg daily or placebo for 1 years	Increase in lean mass, decrease in fat mass, Increase in bone mineral density
Dean et al. 2004	RCT	*n* = 371, 21–81 years, T mean 234 ng/dL	T gel 50 or 100 mg per day or T patch or placebo for 12 months	Increase in mineral bone density, Increase in lean mass, decrease in fat mass, improvement of mood, and sexual function
Wang et al. 2004	RCT for 6 months plus 36 months extension study	*n* = 123, 19–68 years, T < 10.4 nmol/L	T gel 5, 7.5 or 10% per day for 42 months or T patch (RCT phase)	Increase in lean mass, decrease of fat mass, improvement of mood and sexual function, increase of bone mineral density

crow's feet. Randomized, placebo-controlled, prospective multicentre trial have been conducted for Botox/Botox, Cosmetic/Vistabel/Vistabex (Allergan Inc., Irvine, CA), Dysport/Reloxin (Ipsen Ltd., Maidenhead/Berkshire, UK), and Xeomin (Merz Pharma, Frankfurt/Main, Germany) (20). Concerning new developments the present authors will focus on objective assessment of BTXA effects, BTXA brow lift, and combinations with other approaches in facial ECD.

Although the effect of chemodenervation by BTXA on hyperfunctional lines is obvious, recent developments gained for objective assessment. Heckmann and Schön-Hupka (2001) used standardized photography combined with digital image analysis in 30 patients with glabelar or frontal lines. Serial photographs with digital overlay technique were able to demonstrate that BTXA injections decreased upward brow mobility by 71% at 12 weeks after treatment. Frowning was decreased by 57% and the brow-to-brow distance in repose decreased by 13% (21).

Skin texture, however, is a three-dimensional quality. In a prospective open trial a silicon replica technique was used to evaluate the effect of BTXA on glabelar folds. The replicas were further analyzed for roughness, anisotropy, microsulcus number, and width by scanning electron microscopy. During a follow-up period of 6 months, significant improvement was noted for the number furrows, the average width of furrows, and the directionality index of skin lines as well as the average of skin roughness (22).

Three-dimensional profilometry with optical triangulation and digital image processing is another attempt to objective assessment. With this technique there is no need to produce replicas, but measurements are performed directly on the patient's skin surface. In a study with 24 patients treated with BTXA for forehead lines a significant improvement of skin profiles was seen over 8 months. The three-dimensional analysis is more complex but comes closer to the clinical approach than a two-dimensional effort (23).

In contrast to the former techniques, which depend on static images, the complex automated facial image analysis (AFIA) uses computer vision to quantitatively measure facial motion. Facial features are manually marked in the initial image and then automatically tracked across the image sequence. In a pilot study, eight patients with ocular or oral synkinesis obtained BTXA. AFIA was

performed before and after the injections. In each patient, 35 facial points were marked on the digital images. AFIA provides information about movement from the entire digitized sequence of facial expression including the speed of motion, acceleration, direction of motion, and displacement (24).

The brow contour shows gender differences. The peak of the female brow may be as far as the lateral canthus, whereas the brow arcs are above the orbital rim. In men the brow rests along the orbital rim. The brow position is affected by the frontalis muscle, which is the only elevator, and the depressors, i.e., corrugator supercilli, procerus, depressor supercilii, and orbicularis oculi muscles. Alteration of brow position by BTXA may be optimally used in a younger patient who desires a brow lift but does not want surgery (25).

The present authors can differentiate a medial brow lift and a lateral brow lift.

The medial brow lift can be achieved by a similar injection technique as for frown lines. The usual dosage is about 20 U Botox or Xeomin or 5 U Dysport. To achieve an optimal result, injections into corrugator supercilii should be below or at the level of the brow and to avoid injections into the frontalis fibres. The procerus muscle is treated by an injection just above the radix and 2 cm above. The depressor supercilii muscle is targeted by a single injection just inferior and lateral to the medial head of the brow. Exact injection technique and concentrated solution are necessary to avoid diffusion of BTXA (25). Overdosing will result in an unesthetic surprised look (26).

The lateral brow is depressed by the orbicularis oculi muscle. If the parts of the muscle just beneath the lateral brow are treated with BTXA, the lateral brow can be lifted. Usually, half of the dosage used for medial brow lift is enough. The injections should start at the high point and go laterally immediately inferior to the brow. To further mobilize the lateral brow, the upper part of crow's feet need another injection lateral to the orbital rim. The injection is just superficial intradermal using 10 U Botox. Ahn et al. reported on lateral brow lifts in 22 patients. They used 16–20 U Botox injected in the superolateral part of the orbicularis oculi muscle, which produced an average of 4.8 mm elevation in the height of the lateral brow and 1 mm at the mid-pupil level (27,28).

Brow contouring is possible by weakening the medial and lateral brow depressors, resulting in some elevation. The most significant adverse effect of BTXA injections in that area is lid ptosis with an incidence of up to 1%. This effect is temporary, lasting about 2–3 weeks. It can be treated by apraclonidine eye drops that contract Mueller's muscle to raise the lid about 1 mm (29).

Brow ptosis occurs after overdosing BTXA. Ectropium or diplopia are much less common possible adverse effects. Bruising is more common for crow's feet (29). Compared with surgical procedures, chemodenervation is less adequate for the aging face (30).

Botulinum toxin A can be used in conjunction with other ECD procedures to ensure an optimum in facial rejuvenation. Yamauchi et al. combined periorbital laser resurfacing with BTXA. First, the skin surface should be smoothed by BTXA, afterwards laser pulses can be placed more evenly as the patient is unable to wrinkle the skin during the procedure (31). Other combinations for the facial rejuvenation include chemical peels to improve superficial texture and remove pigmentations, intense pulsed light (IPL) or radiofrequency for tightening the skin (32–34).

The combination of fillers with BTXA is another interesting option. Wrinkling in the aging face is a complex phenomenon involving muscles, laxity, and loss of subcutaneous tissue volume. The rejuvenation with fillers combined with BTXA affects both volume loss and muscular hyperactivity. BTXA is administered about 1 week before filler injections or at the same setting. Preferred indications include resting glabelar folds, brow height adjustment, horizontal forehead lines, nasojugal folds, and resetting facial contours in the zygomatic and the perioral region. Commonly used dermal fillers are based on collagen and hyaluronic acid. Such fillers are biodegradable. The injection of these fillers is deep dermal or deep subdermal (as for resetting the zygomatic region). For the latter indication, polylactic acid would be another option. It has been shown that not only the immediate results are promising but also the effect seems to be longer lasting than with BTXA or fillers alone (35,36). In a prospective three-arm study with 65 patients treated for glabelar frown lines, the combination of BTXA with a collagen filler showed a significant better improvement after 1 month and significantly better maintenance at 3 months that monotherapy with either filler or BTXA (37). Intradermal microinjections (1 U of either Dysport or Botox) and hyaluronic acid gel (Restylane Vital) can be combined for facial rejuvenation even in the more difficult to treat areas as the periorbital area (38).

Epinephrine 1 : 100,000 is capable to enhance the effect of BTXA by 30–45% compared to BTXA

alone for crow's feet as shown by a pilot trial involving 14 patients (39). It is supposed that epinephrine increases the effective dosage by minimizing dilution by blood circulation.

Although the effect of BTXA is temporary, a regular long-term treatment from the mid-20s is capable to prevent the development of imprinted facial lines at rest and the crow's feet as well. Such a slow-down of the facial aging process was nicely shown by a comparison in identical twins for a period of 13 years (40).

Cellulite (gynoid lipodystrophy)

Cellulite is a physiologic gender-linked condition clinically characterized by an orange-peel aspect of skin surface, later on mixed with irregular dimpling and lumpy-bumpy cobbles. Predominate localization is on thighs and buttocks.

This condition is a result of adipose tissue protrusions to the dermis, enlargement of fat lobules and alterations of the network of connective tissue strands that connect the dermis to deeper tissue layers (41). Proteoglycan deposits can also be found (42).

High-resolution in vivo magnetic resonance demonstrated that cellulite grading was corresponding to diffuse pattern of extrusion of adipose tissue into dermis, to the percentile of adipose versus connective tissue in a given volume of hypodermis, and the percentile of hypodermic invaginations inside the dermis (43). The interaction of estrogens with matrix metalloproteinase might be a clue to better understanding the biochemistry of this condition (44).

Although cellulite is for sure no disease, many women seek treatment for improvement. There are many different treatments described in the literature that are frustrating. Usually the more treatments are described the less effective they are. Although various treatments have been shown to be ineffective or even harmful (45), recent developments provide some hope.

Smalls et al. (2006) investigated whether controlled weight loss would improve cellulite. The results were mixed. There was improvement in those with higher initial body mass index and significant weight loss, but in others the condition worsened. Weight loss is a good starting point in obese women but alone it is not enough. Even for the combination of diet and regular exercise there is no scientific data proving its efficacy (46).

Topical use of anticellulite cream has not often been well documented. However, recent investigations with herbal cream containing caffeine, black pepper seed extract, sweet orange peel, ginger root extract, green tea extract, cinnamon bark extract, and Capsicum annum resin in 40 women provided evidence of clinical improvement during a 4-week course (47). Because all women also used neoprene shorts, it remains unclear whether the herbals would be as effective when used alone. How would the cream work? The authors suggested stimulation of microvascular blood flow and lymphatic flow as wells as lipolysis.

Topical caffeine solution twice daily for 30 days decreased thigh and hip circumferences. Despite the clinical effects in this investigation, topical caffeine had no significant impact on parameters of microcirculation (48). What about coffee drinking? No such study is available.

Topical retinol during a 6-month period of treatment partially increased skin elasticity and decreased viscosity. There were objective effects in the lab but in clinical use irregularities and lumpy-bumpy appearance of skin did not improve (49).

Mesotherapy is a widely used albeit not scientifically approved method with multiple injections to deliver various ingredients into the skin. In vitro isoproterenol, aminophylline, yohimbine, and melilotus stimulate lipolysis alone, and lipolysis is further enhanced by combining lipolytic stimulators in mesotherapy solutions. Lidocaine is antilipolytic in vitro (50). For in vivo use, there are safety concerns related to the substances injected. Evidence-based medicine is missing for mesotherapy in cellulite (51).

In a pilot study, 12 women were treated twice weekly with a radiofrequency (RF)-light-based device for eight to nine treatments. The device called VelaSmooth™ (Syneron Medical Ltd, Yokneam, Israel) delivers bipolar RF, infrared light, and a pulsatile vacuum suction through a handheld applicator that is pressed directly against the skin. Each treatment lasted 30–45 minutes with an infrared light and RF power of 20 W and a negative, vacuum pressure of 200 millibars. Stimulation of lymphatic and blood flow and strengthening of the fibrous network by heating are possible ways of action. In this study and two others with the same device, 90–100% of patients noted an improvement of cellulite lasting for months (52–54).

A single-center study compared VelaSmooth™ with another combined approach, i.e., low-energy diode laser, contact cooling, suction, and massage (TriActive™; Cynosure, Chelmsford, MA) (55). Twenty women were treated twice a week for 6 weeks with a randomization of TriActive on one site and

VelaSmooth on the other site. Both methods showed an equal efficacy. In a pilot study combining application of a retinyl-based cream with IPL for a 12-week course in 20 patients IPL improved cellulite. The effect was not better with combination than with IPL alone (56). However, the cream may create some other beneficial effects. The major point is, IPL can stimulate collagen synthesis and make the dermis denser. A denser dermis, on the other site, makes fat less likely to herniated.

Recently, a controlled, double-blinded study has been conducted in nine women with grade II–III thigh cellulite to evaluate the efficacy and safety of a phosphatidylcholine-based, cosmeceutical anticellulite gel combined with a light-emitting diode (LED) array at the wavelengths of red (660 nm) and near-infrared (950 nm). The female volunteers were randomly treated twice daily with an active gel on one thigh and a placebo gel on the control thigh for 3 months for a total of 24 treatments. At the end of 3 months, eight of nine thighs treated with the phosphatidylcholine-based, anticellulite gel and LED treatments were downgraded to a lower cellulite grade by clinical examination, digital photography, and pinch test assessment. Digital ultrasound at the dermal-adiposal interface demonstrated not only a statistically significant reduction of immediate hypodermal depth, but also less echo-like intrusions into the dermal layer. Three of six biopsies from thighs treated for 3 months with the active gel and LED treatments demonstrated less intrusion of subcutaneous fat into the papillary and reticular dermis than in placebo- and LED-treated thighs. Patients experienced minimal and transient side effects that included pruritus, erythema, and swelling. Fifteen months after treatment, five responsive thighs reverted back to their original cellulite grading, indicating a need for maintenance treatment (57).

There are also surgical procedures available. A minimal invasive procedure has been developed by Hexsel and Mazzuco (58). They used local anesthesia, inserted a notched catheter into the subcutaneous tissue, and moved it manually parallel to the surface in a repetitive manner. By breaking the connective tissue adhesions of the dermis, the skin surface appearance is smoothened. In a retrospective trial, 232 women showed improvement of surface depressions and reported a high degree of satisfaction. There is little downtime after the procedure because of bruising, pain and hemosiderosis (58).

Liposculpture in tumescence anesthesia is a safe and standardized method to reduce subcutaneous fat tissue – so far, so good. However, the fibrous attachments tethering the dermis to subcutaneous layers will not be affected. Therefore, liposculpture is not a method to treat cellulite (59). Whether it might be a method to prevent cellulite has yet not been investigated systematically. The recent developments in laser lipolysis and laser-assisted liposuction allow treating body areas of flaccidity and irregularities (60–63).

Histologic investigations demonstrated high efficacy in adipocyte destruction and heat coagulation of collagen fibres and blood microvessels (64). By reorganization of the collagen network the procedure leads to skin tightening that seems to have a beneficial effect on cellulite (61) but has yet not been studied systematically.

Lipotransfer for midface contouring

The white adipose tissue of the subcutaneous layer results from differentiation of mesenchymal cells into pre-adipocytes and mature adipocytes. Genome-wide expression profiles of preadipocytes from abdominal subcutaneous, mesenteric, and omental fat deposits are distinct (65). Autologous fat is not immunogenic, easy to harvest and implant, and surprisingly long lasting (66).

Lipotransfer, also called lipofilling, fat transfer, or lipoinjection, is an old technique developed in the 19th century (67). It is a commonly performed procedure in particular for midface contouring, but other indications developed as well (68–70).

Recently the technique has been studied systematically concerning the mode of fat harvest, preparation, storage, and use in facial contouring. It was shown that lipotransfer covers not only mature adipocytes but adipose-derived stromal cells (ASC) and preadipocytes (71). Excisional harvest is better than blunt or needle harvest (72). Fine needles seem to gain better fat cell viability than liposuction cannulas (73). In our hands 18 G needles have been found to be most convenient, as thinner needles may cause disruption of fat cells.

Anesthesia of the donor site is considered as a negative factor for fat cell survival although the various techniques do not seem to have a significant influence on adipocyte transfer. Vasoconstriction before fat extraction supports the maintenance of adipocyte viability (74). Local anesthetics, however, show a significant influence on viability of preadipocytes (75).

Cryopreservation of fat cells without cryoprotective agent causes an almost complete

depletion of metabolic activity as measured by glycerol-3-phosphate-dehydrogenase. Up to 54% of baseline metabolic activity can be preserved by adding cryoprotective agents (76). The addition of 10 μM coenzyme Q10 to adipocytes reduces stress-induced apoptosis (77). The recovering of viable adipocytes from cryopreserved samples can be further improved by controlled freezing compared to direct freezing at –20°C (78).

Transplantation of adipose tissue provides an excellent long-term soft tissue augmentation (FIGS. 1 and 2). It has been observed that transplanted adipose tissue also improves surrounding tissues into which the fat is placed (79). In an experimental study, it was shown that fat transfer enriched with ASC provides better results than aspirated fat alone. ASC differentiated into vascular endothelial cells thereby contributing to neoangiogenesis (80).

Pre-adipocytes are an interesting source for adipose tissue regeneration and lipofilling. Some factors have been identified that enhance the adipogenic conversion of pre-adipocytes. Fibrin matrix and basic fibroblast growth factor are effective in that way. In addition, basic fibroblast growth factor enhances neovascularization in the newly formed adipose tissue (81). It was demonstrated that freeze-thawed preadipocytes constantly show typical adipocytic functions in terms of lipid content, leptin secretion, adipogenic gene expression, and viability. After transplantation they form adipose tissue similar to those developed from fresh differentiated adipocytes. In addition, CD34-positive endothelial cells were identified in the implants contributing to improved blood supply (82).

In recent time, adult stem cell transfer by lipofilling has been debated. Mesenchymal stem cells (MSC) are nonhaematopoietic stem cells residing in bone marrow but adipose tissue as well. MSC are characterized by expression of a wide range of surface markers but lack of markers typical of hematopietic or endothelial lineages including CD14, CD34, and CD45 (83,84).

In vitro MCS can differentiate into adipocytes when treated with a cocktail containing dexamethasone, isobutyl methylxanthine, and indomethacin. Changes in the bone morphogenetic protein receptor are intrinsic factors for the commitment into adipogenic or osteoblastic cell lines (84). A denatured collagen type I matrix preserves MCS adipogenic potential during ex vivo expansion (85).

MCS have been identified in white adipose tissue named adipose tissue-derived stem cells (ADSC). They share most cell surface markers with MCS. The two exceptions to the rule are CD49d expressed by ADSC only and CD106 expressed by MCS only. ADCS when grown in culture express several adipocytic genes including lipoprotein lipase, leptin, and peroxisome-proliferator activated receptor – 2 (86).

Adipose tissue-derived stem cells can be grown in vitro using a gelatine sponge as scaffold. After transplantation on severe combined immunodeficient mice, ADSC turns into mature adipose tissue within 4 weeks (87). Encapsulation of MSC in poly (ethylene glycol) diacrylate hydrogel retains defined shape and dimensions after in vivo implantation (88). Other potential scaffolds for engineered tissue include poly(lactic-coglycolic acid) (89), porous collagenous microbeads (90), and fibrin (91).

Laser-assisted liposuction

Liposuction is the most popular esthetic procedure performed is cosmetic surgery. Despite the evident progress related to the development of new resources such as the use of tumescent solution, ultrasound, and power-assisted liposuction, the major concern in relation to this procedure is the amount of the aspirated volume, its repercussion in hemodynamic aspect, the surgical trauma, and quality of the recovery period.

The use of laser in direct action in the fatty tissue was initially described by Apfelberg and colleagues in the early nineties (92). Recently, new lasers concepts have been adapted for the treatment of lipodystrophy in the body and face using a neodymium, yttrium, aluminum, garnet (Nd-YAG) laser, at a wavelength of 1064 nm. The current principles and technique of laser-assisted liposuction were initially described by Blugerman, Schavelzon, and Goldman using a pulsed 1064 nm Nd-YAG laser (Smartlipo, Deka, Italy) (93,94). Many studies showed interesting aspects related to the use of the subdermal 1064 nm Nd-YAG laser not only in the fat but also in surrounding tissues such dermis, vessels, and sweat glands (95–98).

The main indication for laser-assisted liposuction is in the treatment of localized fat. Treatment is performed in direct contact with the fatty tissue or other targets such as sweat glands or dermis via optical fiber delivered through a 1-mm diameter cannula. When in contact with the previously infiltrated fatty tissue, the light energy produced by the laser is absorbed and converted into heat,

FIG. 1. Facial atrophy in the cheek and lower lid region. (A) Before treatment, (B) 1 year after autologous lipotransfer.

thereby expanding the adipocyte contents and rupturing the cell membrane. A photomechanic effect may also play a role in cellular lysis, as a result of the rapid absorption by and heating of the cell. The procedures can be performed after local tumescent subcutaneous infiltration of a Klein's solution or a similar warm solution containing normal saline solution, epinephrine and sodium bicarbonate. Through thermal and photomechanical effects the laser action can produce cellular lysis, disrupt the thin adipocyte membrane, obliterate small blood vessels in the subcutaneous layer and fatty tissue, coagulate collagen in deep dermis, reorganize the reticular dermis and denatured sweat glands. As a consequence of these effects related to the laser, it is possible to transform a dense fatty tissue into a less dense solution, facilitating the aspiration of this material. The product of the cellular lysis is usually removed using negative pressure of around 350 mmHg to 450 mmHg in conjunction with a 2.5 mm suction cannula decreasing the trauma to the tissues. Potential complications related to the

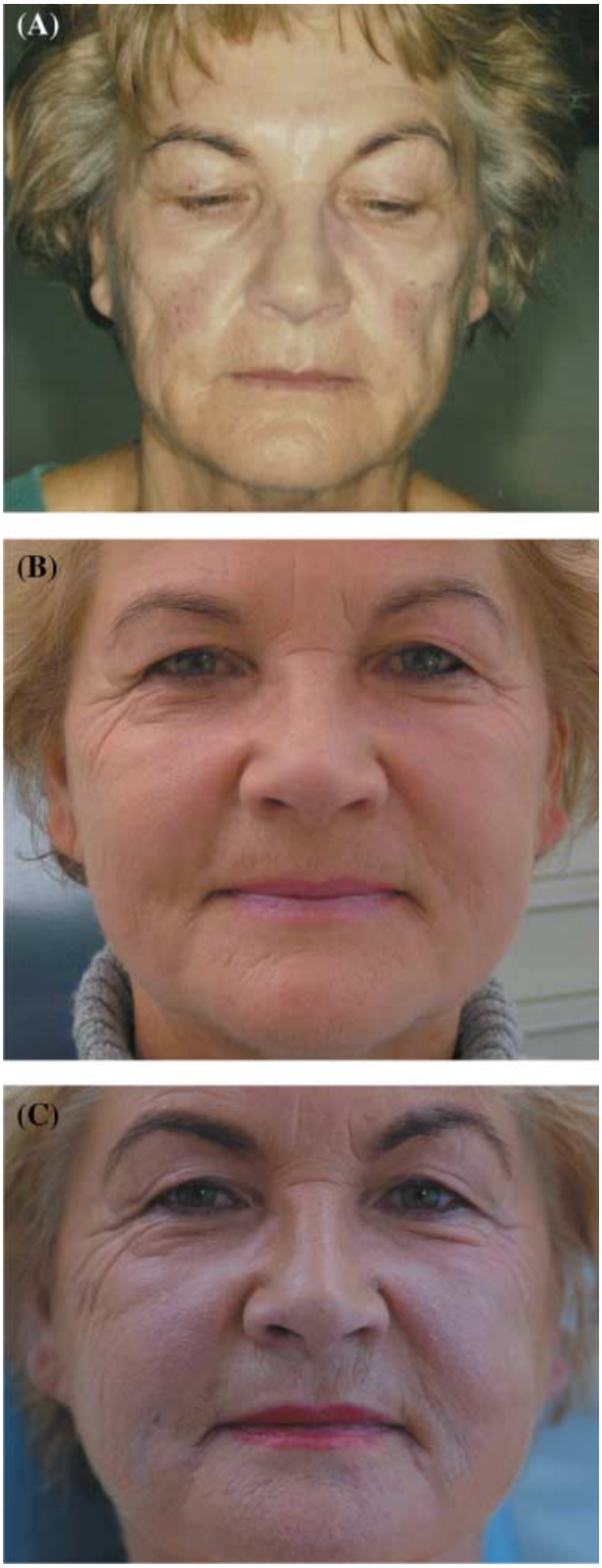

FIG. 2. Lipotransfer for facial sculpturing in a 70-year-old woman. (A) Before treatment, (B) after 1 year, and (C) after 4 years with a stable result.

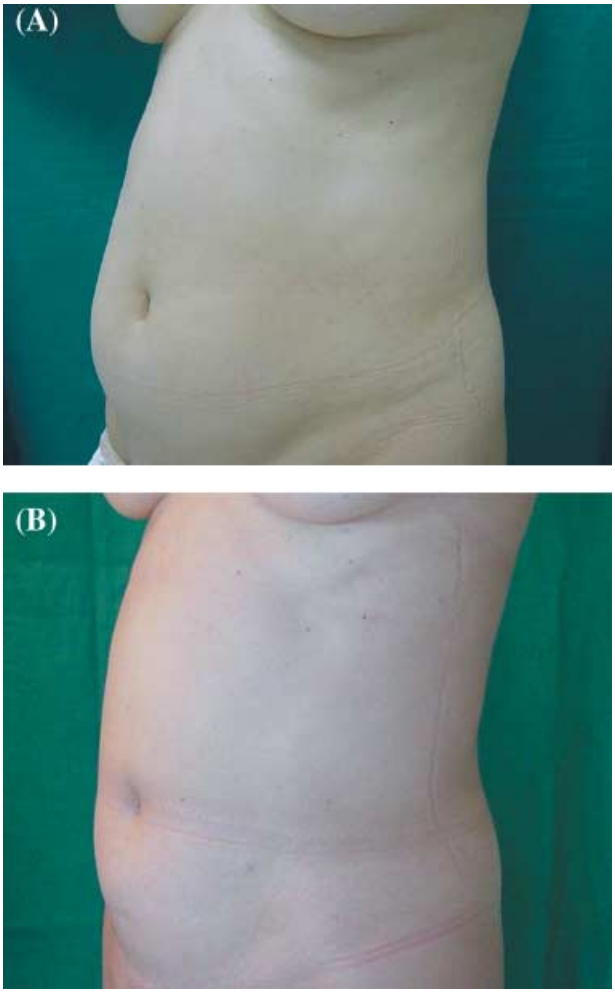

FIG. 3. Laser-assisted lipolysis of subcutaneous adipose tissue deposits of flanks and abdomen in a 33-year-old woman. (A) Before treatment, (B) after treatment.

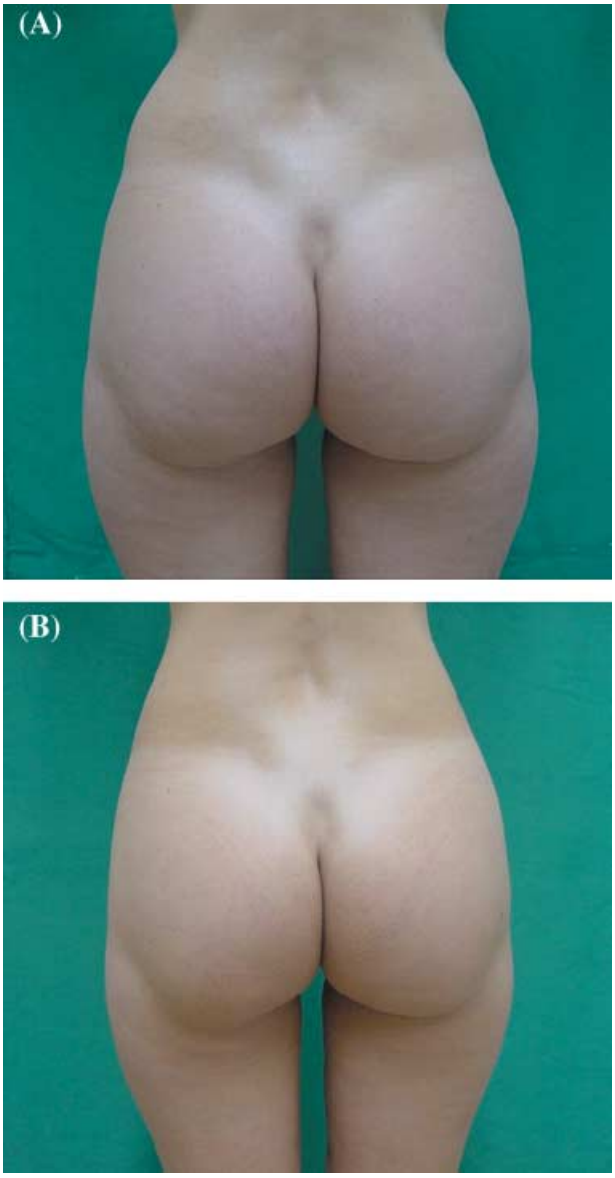

FIG. 4. Laser-assisted lipolysis of the buttock area. (A) Before treatment, (B) 23 months after treatment.

procedure are similar to a regular liposuction technique including asymmetry, hyper and hypo correction and infection. Burns also represent a potential complication. Histological findings suggest several positive benefits brought by the use of the Nd:YAG laser, which include skin retraction as a result of new collagen formation and a reduction in pre-operative and postoperative bleeding as well as in the population of adipocytes. The observation of a reddish color from the Helium-Neon source associated to the equipment, as a result of transillumination, makes the procedure very precise and accurate, as it allows the surgeon to identify the exact place where the tip of the 1 mm microcannula containing the optical fiber is and where the laser is working. It is a very useful characteristic mainly in special cases such as in the treatment of severe cases of cellulite, another interesting indication for this technique. The 1064 nm Nd-YAG laser due to its physical characteristics reach the oxyhemoglobin in small vessels located in the treated areas, coagulates these vessels. The collagen coagulation with a consequent neocollagenesis in the deep dermis is another important effect related to the laser which contributes to adequate skin tightening. This capacity to produce skin retraction is very important in the treatment of patients with some skin laxity, mainly in submental region, abdominal

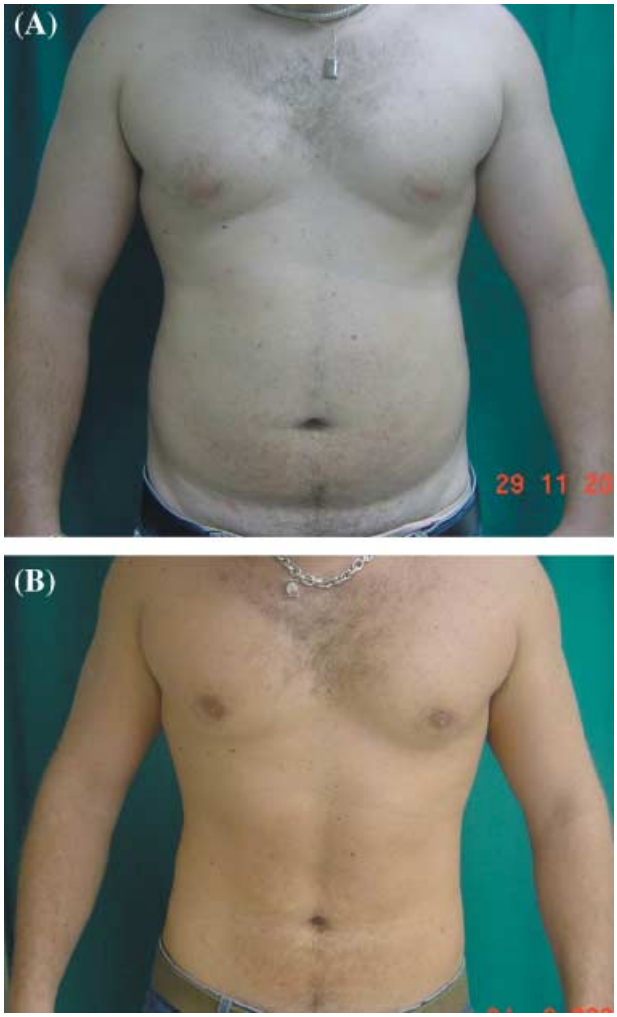

FIG. 5. Laser-assisted lipolysis of the abdominal area and of gynecomastia. (A) Before treatment, (B) after treatment.

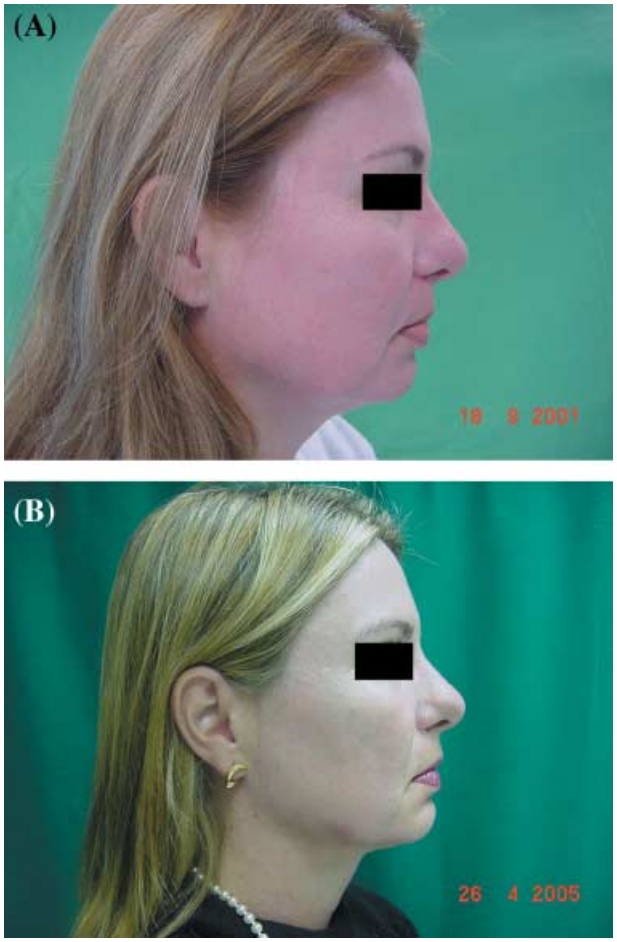

FIG. 6. Submental lipodystrophy. (A) Before treatment, (B) 4 years after laser-assisted lipolysis with marked improvement of the jaw line and the submental region.

region, arms and thighs as well as in cellulite (99–101) (FIGS. 3–6).

Bromidrosis represents another indication for this type of laser (102). The subdermal laser-assisted axillary hyperhidrosis treatment using a 1064 nm Nd-YAG laser produces collapse of eccrine glands and resulted in significant clinical improvement (103,104).

Lipomas, gynecomastia, liposuction of flaps, herpes and oral disorders, stretch marks, scars and some minor vascular alterations represent other indications for this laser. Although the positive effects observed by many authors in many scientific publications, more studies and follow-ups are needed in order to deeply determine the characteristics and effects of the pulsed 1064 nm Nd-YAG laser and new indications.

References

1. Fimmel S, Zouboulis CC. Influence of physiological androgen levels on wound healing and immune status in men. Aging Male 2005: **8**: 166–174.
2. Fimmel S, Kurfürst R, Bonté F, Zouboulis CC. Responsiveness to androgens and effectiveness of antisense oligonucleotides against the androgen receptor on human epidermal keratinocytes is dependent on the age of the donor and the location of cell origin. Horm Metab Res 2007: **39**: 157–165.
3. Shikata N, Kurokawa I, Andachi H, et al. Expression of androgen receptors in skin appendage tumors: an immunohistochemical study. J Cutan Pathol 1995: **22**: 149–153.
4. Azzi L, El-Alfy M, Labrie F. Gender differences and effects of sex steroids and dehydroepiandrosterone on androgen and oestrogen α receptors in mouse sebaceous glands. Br J Dermatol 2006: **154**: 21–27.
5. Beier K, Ginez I, Schaller H. Localization of steroid hormone receptors in the apocrine sweat glands of the human axilla. Histochem Cell Biol 2005: **123**: 61–65.

6. Tamer C, Oksuz H, Sohut S. Androgen status of the non-autoimmune dry eye. Ophthalmic Res 2006: **38**: 280–286.
7. Heaton JPW. Hormone treatments and preventive strategies in the aging male: whom and when to treat? Rev Urol 2003: **5** (Suppl. 1): S16–S21.
8. Zouboulis CC. Intrinsische hautalterung. Eine kritische bewertung der rolle der hormone (Intrinsic ageing of skin. A critical assessment of the role of hormones). Hautarzt 2003: **54**: 825–832.
9. Schreiber G, Wollina U. Hautalterung und Hormone beim Mann (Skin ageing and hormones in males). Kosmet Med/ Cosmet Med 2006: **27**: 202–209.
10. Choi BG, McLaughlin MA. Why men's heart break: cardiovascular effects of sex steroids. Endocrinol Metab Clin North Am 2007: **36**: 365–377.
11. Morgentaler A. Testosterone replacement therapy and prostate cancer. Urol Clin North Am 2007: **34**: 555–563.
12. Khera M, Lipshultz LI. The role of testosterone replacement therapy after radical prostatectomy. Urol Clin North Am 2007: **34**: 549–553.
13. Tenover JS. Effects of testosterone supplementation in the aging male. J Clin Endocrinol Metab 1992: **75**: 1092–1098.
14. Sih R, Morley JE, Kaiser FE, Perry HM 3rd, Patrick P, Ross C. Testosterone in older hypogonadal men: a 12-month randomized controlled trial. J Clin Endocrinol Metab 1997: **82**: 1661–1667.
15. Snyder PJ, Peachey H, Hannoush P, et al. Effect of testosterone treatment on body composition and muscle strength in men over 65 years of age. J Clin Endocrinol Metab 1999: **84**: 2647–2653.
16. Kenny AM, Prestwood KM, Gruman CA, Fabregas G, Biskup B, Mansoor G. Effects of transdermal testosterone on lipids and vascular reactivity in older men with low bioavailable testosterone levels. J Gerontol A Biol Sci Med Sci 2002: **57**: M460–M465.
17. Dean JD, Carnegie C, Rodzvilla J Jr, Smith T. Long-term effects of Testim® 1% testosterone gel in hypogonadal men. Rev Urol 2004: **6** (Suppl. 6): S22–S29.
18. Wang C, Cunningham G, Dobs A, et al. Long-term testosterone gel (AndroGel) treatment maintains beneficial effects on sexual function and mood, lean and fat mass, and bone mineral density in hypogonadal men. J Clin Endocrinol Metab 2004: **89**: 2085–2098.
19. Leow MKS, Loh KC. Controversial endocrine interventions for the aged. Singapore Med J 2006: **47**: 569–579.
20. De Boulle KLV. Botulinum neurotoxin type A in facial aesthetics. Expert Opin Pharmacother 2007: **8**: 1059–1072.
21. Heckmann M, Schön-Hupka G. Quantification of the efficacy of botulinum toxin type A by digital image analysis. J Am Acad Dermatol 2001: **45**: 508–514.
22. Dessy LA, Mazzocchi M, Rubino C, Mazzarello V, Spissu N, Scuderi N. An objective assessment of botulinum toxin A effect on superficial skin texture. Ann Plast Surg 2007: **58**: 469–473.
23. Levy JL, Pons F, Jouves E. Management of the ageing eyebrow and forehead: an objective dose–response study with botulinum toxin. J Eur Acad Dermatol Venereol 2006: **20**: 711–716.
24. Rogers CR, Schmidt KL, VanSwearingen JM, et al. Automated facial image analysis. Detecting improvement in abnormal facial movement after treatment with botulinum toxin A. Ann Plast Surg 2007: **58**: 39–47.
25. Chen AH, Frankel AS. Altering brow contour with botulinum toxin. Facial Plast Surg Clin N Am 2003: **11**: 457–464.
26. Frankel AS, Kramer FM. Chemical brow lift. Arch Otolaryngol Head Neck Surg 1998: **124**: 321–323.
27. Ahn MS, Catten M, Maas CS. Temporal brow lift using botulinum toxin A. Plast Reconstr Surg 2000: **105**: 1129–1135.
28. Maas CS, Kim EJ. Temporal brow lift using botulinum toxin A: an update. Plast Reconstr Surg 2003: **112**: 109S–112S.
29. Wollina U, Konrad H. Managing adverse events associated with botulinum toxin A: a focus on cosmetic procedures. Am J Clin Dermatol 2005: **6**: 141–150.
30. Arneja JS, Larson DL, Gosain AK. Aesthetic and reconstructive brow lift: current techniques, indications, and applications. Ophthal Plast Reconstr Surg 2005: **21**: 405–411.
31. Yamauchi PS, Lask G, Lowe NJ. Botulinum toxin type A gives an adjunctive benefit to periorbital laser resurfacing. J Cosmet Laser Ther 2004: **6**: 145–148.
32. Shah GM, Kilmer SL. Combined nonablative rejuvenation techniques. Dermatol Surg 2005: **31**: 1206–1210.
33. Bosniak S, Cantisano-Zilkha M, Purewal BK, Zdinak LA. Combination therapies in oculofacial rejuvenation. Orbit 2006: **25**: 319–326.
34. Rendon MI, Effron C, Edison BL. The use of fillers and botulinum toxin type A in combination with superficial glycolic acid (α-hydroxy acid) peels: optimizing injection therapy with the skin-smoothing properties of peels. Cutis 2007: **79** (Suppl. 1): 9–12.
35. Coleman KR, Carruthers J. Combination therapy with BOTOX™ and fillers: the new rejuvenation paradigm. Dermatol Ther 2006: **19**: 177–188.
36. Levy P. Combining with fillers – gold standard in practice. Expert Approaches to Using Botulinum Toxins 2007: **6**: 1–11.
37. Patel MP, Talmor M, Nolan WB. Botox and collagen for glabellar furrows: advantages of combination therapy. Ann Plast Surg 2004: **52**: 442–447.
38. Becker-Wegerich P. Mikroinjektionen mit botulinumtoxin A in kombination mit hyaluronsäure (Microinjections with botulinum toxin A in combination with hyaluronic acid). Plast Chir 2006: **6**: 126–129.
39. Hantash BM, Gladstone HB. A pilot study on the effect of epinephrine on botulinum toxin treatment for periorbital rhytides. Dermatol Surg 2007: **33**: 461–468.
40. Binder WJ. Long-term effects of botulinum toxin type A (Botox) on facial lines. Arch Facial Plast Surg 2006: **8**: 426–431.
41. Piérard GE, Nizet JL, Piérard-Franchimont C. Cellulite: from standing fat herniation to hypodermal stretch marks. Am J Dermatopathol 2000: **22**: 34–37.
42. Lotti T, Ghersetich MD, Grappone C, Dini G. Proteoglycans in so-called cellulite. Int J Dermatol 1990: **29**: 272–274.
43. Mirrashed F, Sharp JC, Krause V, Morgan J, Tomanek B. Pilot study of dermal and subcutaneous fat structures by MRI in individuals who differ in gender, BMI, and cellulite grading. Skin Res Technol 2004: **10**: 161–168.
44. Pugliese PT. The pathogenesis of cellulite: a new concept. J Cosmet Dermatol 2007: **6**: 140–142.
45. Sainio EL, Rantanen T, Kanerva L. Ingredients and safety of cellulite creams. Eur J Dermatol 2000: **10**: 596–603.
46. Smalls LK, Hicks M, Passeretti D, et al. Effect of weight loss on cellulite: gynoid lipodystrophy. Plast Reconstr Surg 2006: **118**: 510–516.
47. Rao J, Gold MH, Goldman MP. A two-center, double-blinded, randomized trial testing the tolerability and efficacy of a novel therapeutic agent for cellulite reduction. J Cosmet Dermatol 2005: **4**: 93–102.

48. Lupi O, Semenovitch IJ, Treu C, et al. Evaluation of the effects of caffeine in the microcirculation and edema on thighs and buttocks using the orthogonal polarization spectral imaging and clinical parameters. J Cosmet Dermatol 2007: **6**: 102–107.
49. Piérard-Franchimont C, Piérard GE, Henry F, Vroome V, Cauwenbergh G. A randomized, placebo-controlled trial of topical retinol in the treatment of cellulite. Am J Clin Dermatol 2000: **1**: 369–374.
50. Caruso MK, Roberts AT, Bissoon L, Self KS, Guillot TS, Greenway FL. An evaluation of mesotherapy solutions for inducing lipolysis and treating cellulite. J Plast Reconstr Aesthet Surg 2007; (Epub ahead of print).
51. Rotunda AM, Avram MM, Avram AS. Cellulite: is there a role for injectables? J Cosmet Laser Ther 2005: **7**: 147–154.
52. Wanitphakdeedecha R, Manuskiatti W. Treatment of cellulite with a bipolar radiofrequency, infrared heat, and pulsatile suction device: a pilot study. J Cosmet Dermatol 2006: **5**: 284–288.
53. Alster TS, Tanzi EL. Cellulite treatment using a novel combination radiofrequency, infrared light, and mechanical manipulation device. J Cosmet Laser Ther 2005: **7**: 81–85.
54. Sadick NS, Mulholland RS. A prospective clinical study to evaluate the efficacy and safety of cellulite treatment using the combination of optical and RF energies for subcutaneous tissue heating. J Cosmet Laser Ther 2004: **6**: 187–190.
55. Nootheti PK, Magpantay A, Yosowitz G, Calderon S, Goldman MP. A single, randomized, comparative clinical study to determine the efficacy of the VelaSmooth system versus the TriActive system for the treatment of cellulite. Lasers Surg Med 2006: **38**: 908–912.
56. Fink JS, Mermelstein H, Thomas A, Trow R. Use of intense pulsed light and a retinyl-based cream as a potential treatment for cellulite: a pilot study. J Cosmet Dermatol 2006: **5**: 254–262.
57. Sasaki GH, Oberg K, Tucker B, Gaston M. The effectiveness and safety of topical PhotoActif phosphatidylcholine-based anti-cellulite gel and LED (red and near-infrared) light on Grade II–III thigh cellulite: a randomized, double-blinded study. J Cosmet Laser Ther 2007: **9**: 87–96.
58. Hexsel DM, Mazzuco R. Subcision: a treatment for cellulite. Int J Dermatol 2000: **39**: 539–544.
59. Donifrio LM. Liposuction of the thighs. In: Hanke CW, Sattler G, eds. Liposuction. Philadelphia, PA: Elsevier Saunders, 2005: 93–104.
60. Goldman A, Schavelzon DE, Blugerman GS. Laserlipolysis: liposuction using Nd:YAG laser. Rev Soc Bras Circ Plast 2002: **17**: 17–26.
61. Badin AZD, Moraes LM, Gondek L, Chiaratti MG, Canta L. Laser lipolysis: flaccidity under control. Aesthet Plast Surg 2002: **26**: 335–339.
62. Goldman A. Submental laser-assisted liposuction: clinical experience and histologic findings. Kosmet Med/Cosmet Med 2005: **26**: 4–12.
63. Kim KH, Geroneumus RG. Laser lipolysis using a novel 1064 nm Nd:YAG laser. Dermatol Surg 2006: **32**: 241–248.
64. Ichikawa K, Miyasaka M, Tanaka R, Tanino R, Mizukami K, Wakaki M. Histologic evaluation of the pulsed Nd:YAG laser for laser lipolysis. Lasers Surg Med 2005: **36**: 43–46.
65. Tchkonia T, Lenburg M, Thomou T, et al. Identification of depot-specific human fat cell progenitors through distinct expression profiles and developmental gene patterns. Am J Physiol Endocrinol Metab 2007: **292**: E298–E307.
66. Shiffman MA, Mirrafati S. Fat transfer techniques: the effect of harvest and transfer methods on adipocyte viability and review of the literature. Dermatol Surg 2001: **27**: 819–826.
67. Neuber F. Fettransplantation (Fat transplantation). Verhandl Dtsch Ges Chir 1893: **22**: 66.
68. Kaufman MR, Bradley JP, Dickinson B, 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**: 323–331.
69. Pontius AT, Williams EF III. The evolution of midface rejuvenation: Combining the midface-lift and fat transfer. Arch Facial Plast Surg 2006: **8**: 300–305.
70. 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**: 1150–1158.
71. Butterwick KJ, Nootheti PK, Hsu JW, Goldman MP. Autologous fat transfer: an in-depth look at varying concepts and techniques. Facial Plast Surg Clin North Am 2007: **15**: 99–111.
72. Piasecki JH, Gutowski KA, Lahvis GP, Moreno KI. An experimental model for improving fat graft viability and purity. Plast Reconstr Surg 2007: **119**: 1571–1583.
73. Gonzalez AM, Lobocki C, Kelly CP, Jackson IT. An alternative method for harvest and processing fat grafts: an in vivo study of cell viability and survival. Plast Reconstr Surg 2007: **120**: 285–294.
74. Sommer B, Sattler G. Current concepts of fat graft survival: histology of aspirated adipose tissue and review of the literature. Dermatol Surg 2000: **26**: 1159–1166.
75. Keck M, Janke J, Ueberreiter K. (The influence of different local anaesthetics on the viability of preadipocytes). Handchir Mikrochir Plast Chir 2007: **39**: 215–219.
76. Wolter TP, von Heimburg D, Stoffels I, Groeger A, Pallua N. Cryopreservation of mature human adipocytes: in vitro measurement of viability. Ann Plast Reconstr Surg 2005: **55**: 408–413.
77. Witort EJ, Pattarino J, Papucci L, et al. Autologous lipofilling: coenzyme Q10 can rescue adipocytes from stress-induced apoptotic death. Plast Reconstr Surg 2007: **119**: 1191–1199.
78. Moscatello DK, Dougherty M, Narins RS, Lawrence N. Cryopreservation of human fat for soft tissue augmentation: viability requires use of cryoprotectant and controlled freezing and storage. Dermatol Surg 2005: **31**: 1506–1510.
79. Coleman SR. Structural fat grafting: more than a permanent filler. Plast Reconstr Surg 2006: **118** (Suppl. 3): 108S–120S.
80. Matsumoto D, Sato K, Gonda K, et al. Cell-assisted lipotransfer: supportive use of human adipose-derived cells for soft tissue augmentation with lipoinjection. Tissue Eng 2006: **12**: 3375–3382.
81. Cho SW, Kim I, Kim SH, Rhie JW, Choi CY, Kim BS. Enhancement of adipose tissue formation by implantation of adipogenic-differentiated preadipocytes. Biochem Biophys Res Commun 2006: **345**: 588–594.
82. Kim M, Kim I, Kim SH, et al. Cryopreserved human adipogenic-differentiated pre-adipocytes: a potential new source for adipose tissue regeneration. Cytotherapy 2007: **9**: 468–476.
83. Stosich MS, Mao JJ. Adipose tissue engineering from adult stem cells: clinical implications in plastic and reconstructive surgery. Plast Reconstr Surg 2007: **119**: 71–83.

84. Bobis S, Jarocha D, Majka M. Mesenchymal stem cells: characteristics and clinical applications. Folia Histochem Cytobiol 2006: **44**: 215–230.
85. Mauney JR, Volloch V, Kaplan DL. Matrix-mediated retention of adipogenic differentiation potential by human adult bone marrow-derived mesenchymal stem cells during ex vivo expansion. Biomaterials 2005: **26**: 6167–6175.
86. Strem BM, Hicok KC, Zhu M, et al. Multipotential differentiation of adipose tissue-derived stem cells. Keio J Med 2005: **54**: 132–141.
87. Hong L, Peptan IA, Colpan A, Daw JL. Adipose tissue engineering by human adipose-derived stromal cells. Cells Tissues Organs 2006: **183**: 133–140.
88. Aldhadlaq A, Tang M, Mao JJ. Engineered adipose tissue from human mesenchymal stem cells maintains predefined shape and dimension: implications in soft tissue augmentation and reconstruction. Tissue Eng 2005: **11**: 556–566.
89. Neubauer M, Hacker M, Bauer-Kreisel P, et al. Adipose tissue engineering based on mesenchymal stem cells and basic fibroblast growth factor in vitro. Tissue Eng 2005: **11**: 1840–1851.
90. Rubin JP, Bennett JM, Doctor JS, Tebbets BM, Marra KG. Collagenous microbeads as a scaffold for tissue engineering with adipose-derived stem cells. Plast Reconstr Surg 2007: **120**: 414–424.
91. Torio-Padron N, Baerlecken N, Momeni A, Stark GB, Borges J. Engineering of adipose tissue by injection of human preadipocytes in fibrin. Aesthet Plast Surg 2007: **31**: 285–293.
92. Apfelberg D, Rosenthal S, Hunstad J. Progress report on multicenter study of laser-assisted liposuction. Aesthet Plast Surg 1994: **18**: 259–264.
93. Goldman A, Schavelzon D, Blugerman G. Laser lipolysis: liposuction using Nd:YAG laser. Revista da Sociedade Brasileira de Cirurgia Plástica 2002: **17**: 17–26.
94. Goldman A, Schavelzon D, Blugerman G. Liposuction using neodimium: yttrium-aluminium-garnet laser (abstract). Plast Reconstr Surg 2003: **111**: 2497.
95. Badin A, Moraes L, Godek L, et al. Laser lipolysis: flaccidity under control. Aesth Plast Surg 2002: **26**: 335–339.
96. Neira R, Arroyave J, Ramirez H, et al. Fat liquefaction: effect of low-level laser energy on adipose tissue. Plast Reconstr Surg 2002: **110**: 912.
97. Brow S, Rohrich R, Kenkel J, et al. Effect of low-level laser therapy on abdominal adipocytes before lipoplasty procedures. Plast Reconstr Surg 2004: **113**: 1796.
98. Kim K, Geronemus R. Laser lipolysis using a novel 1064 nm Nd:YAG laser. Dermatol Surg 2006: **32**: 241–248.
99. Goldman A. Submentale laserassistierte Liposuktion: klinische Erfahrungen und histologische Ergebnisse. Kosmet Med Cosmet Med 2005: **26**: 4–11.
100. Goldman A. Submental Nd:YAG laser-assisted liposuction. Lasers Surg Med 2006: **38**: 181–184.
101. Ichikawa K, Miyasaca M, Tanaka R, et al. Histologic evaluation of the pulsed Nd:YAG laser for laser lipolysis. Laser Surg Med 2005: **36**: 43–46.
102. Kunachak S, Wongwaisayawan S, Leelaudomlipi P. Noninvasive treatment of bromidrosis by frequency-doubled Q-switched Nd:YAG laser. Aesthetic Plast Surg 2000: **24**: 198–201.
103. Klöpper M, Fischer G, Blugerman G. Laser-assisted suction of axillary sweat glands and axillary epilation. In: Shiffman MA, Di Giuseppe A, eds. Liposuction – principles and practice. Berlin, Heidelberg: Springer-Verlag, 2006: 505–515.
104. Goldman A, Wollina U. Subdermal Nd-YAG laser for axillary hyperhidrosis. Dermatol Surg 2008; in press.