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Laser-Assisted Liposuction in Face and Body Contouring

Zoran Žgaljardić and Ivonne Žgaljardić

Abstract

Laser liposuction was developed as minimally invasive liposuction technique where energy breaks adipocytes (comparing with traditional liposuction where disruption is manual). After its implementation in the early 1990s, various academic reports were published that showed superiority of the laser assisted liposuction over standard tumescent technique. After tissue damage with photo-optical thermal energy, histological changes result in adipocyte disruption, blood vessel coagulation and neocollagenesis. The clinical manifestation of the latter is significant skin tightening and faster and more comfortable recovery. The diameter of the laser fiber is very small. Therefore, it is possible to reach adipose tissue entrapped in fibrotic areas and also superficially under the skin. The lysis of the given adipose tissue enables the subsequent suction with microcannulas. That explains the widespread use of the laser-assisted liposuction in the face and neck. Due to the significant skin tightening, the procedure can be done solely for rejuvenation purposes and is called endolight lifting. The possibility to reach fat in the fibrotic areas makes laser-assisted lipolysis/liposuction ideal procedure for contouring irregularities from previous body contouring procedures.

Keywords: laser, liposuction, endolight lifting, skin tightening

1. Introduction

Body contouring surgeries have been one of the most common procedures among all the procedures in cosmetic surgery. According to the report of the American society of plastic surgeons, in the 2019, liposuction has been the second most common procedure with 3% rise compared with the previous year [1]. During the last 30 years many new technologies have emerged and have been implemented in the liposuction procedure in order to improve the results and facilitate recovery. First report on the laser use for liposuction was made by Dressel in 1990 but the report was unable to prove clinical advantages so the technique did not get the FDA (Food and Drug Administration) clearance [2]. Significant breakthrough was made by Apfelberg in 1994. He conducted an FDA-approved study (subsequently he expanded the study in 1996) that proved the benefits of the laser use in the liposuction technique in terms of reduced bleeding, discomfort and tissue swelling. All of the latter resulted in faster recovery [3, 4]. Due to those reports, Apfelberg is considered to be the father of the laser assisted liposuction. Many reports followed that proved the superiority of laser assisted liposuction over the standard technique. The articles mainly emphasized diminished blood loss, oedema and recovery time. Besides that, maybe one of the most important features of the laser implementation was the neocollagenesis and

consequently, the skin tightening effect after the procedure. Badin et.al were first to report that benefit [5]. The first laser to be approved by the FDA was 1064 nm Nd: YAG laser (smartLipo, Cynosure) on the 31st October of 2006.

2. Patient evaluation

Good indication is of the utter importance in achieving a satisfactory result. A good candidate for liposuction is considered to have localized subcutaneous fat accumulation without skin laxity. The advantage of the laser-assisted liposuction, as previously mentioned, is collagen formation and the skin tightening effect. Therefore, some amount of skin laxity can be tolerated when performing this method. Thanks to that feature, skin excision surgeries can sometimes be avoided. Unfortunately, there are no reports on the amount of skin laxity that is considered resolvable with this method so the indications are made by surgeon's subjective opinion based on his or her personal experience. Generally, younger patients with good skin tone respond excellent to the photo-thermal effect of the laser.

Special indications:

- Irregularities from previous surgeries
- Pseudogynecomastia with or without breast ptosis
- Turkey neck
- Facial adiposity
- High-definition result
- Multiple lipomas
- Hyperhidrosis

Exclusion criteria:

- Obesity
- Skin in excess with very poor skin quality
- Unrealistic expectations

Preoperatively pinch test should be performed to assess the amount of the subcutaneous fat and the skin in excess. In the beginning, one should avoid treating patients with skin in excess until enough experience is gathered in order to be able to assess the expected postoperative skin tightening effect. All irregularities should be marked and noted with patient in the standing position to avoid losing the 3D image when patient is in the supine position on the operating table. When performing high-definition laser-assisted liposuction, it is important to mark the borders of the underlying muscles. When treating the paranasolabial folds it is important to distinguish the subcutaneous fat from the buccal fat pad since the latter is treated with intraoral surgical excision.

All patient should be preoperatively advised that liposuction is not a substitute for healthy living habits and should not be used as a weight loss procedure but as a body contouring one.

3. Materials and methods

The authors have been using laser assisted liposuction for the past 12 years. The laser used is the diode laser 1470 nm. The settings are as follows: 12w (for abdomen, flanks, back, legs, pseudogynecomastia), 10w for the arms and 6w for the facial area and the submental fat with continuous wave in all areas besides the face (discontinuous wave is used in the face for safety reasons).

There are many advocates for performing liposuction in solely tumescent anesthesia but the authors suggest performing only smaller areas in such manner. If the laser assisted technique is used to achieve skin tightening, the treated area should be wider than the fat accumulation to allow good adaptation of the skin. The authors always perform liposuction under general anesthesia unless the treated area is small (face, flanks of knee area). When treating the submental area in tumescent or local anesthesia one should bear in mind that postoperative nerve palsy can emerge from the lidocaine effect and not due to the intraoperative nerve injury.

The disinfection is made while patient is awake and in standing position and subsequently positioned on the sterile operating table to avoid bacterial contamination.

It is recommended to infiltrate the tumescent fluid (or 0.9%NaCl with epinephrine in 1 L/1 ml 1:1000 ratio when surgery is performed under general anesthesia to avoid the risk of lidocaine toxicity) with the infiltration pump. The use of the pump enables faster performance and uniform fluid distribution. The mechanical pressure on the tissue made by the pump contributes to vasoconstriction and fat cell disruption.

When blanching of the area is achieved, the laser lipolysis can be performed. The back and forth movements of the laser fiber in the tissue should be smooth- the fat cells should be disrupted by the energy applied and not mechanically. The pop-corn sound effect should constantly be heard as a result of laser-tissue interaction. (Video 1, Video 2) Some lasers are equipped with internal thermometer to avoid overheating and subsequent burn and necrosis. If there is no internal subcutaneous thermometer ($>50^{\circ}\text{C}$), external thermometer can be used as a control ($38-42^{\circ}\text{C}$ should not be exceeded) but authors suggest constantly moving the undominant hand over the treated area in order to feel the surface temperature and avoid the overaccumulation of energy. Cold packs can also be used to diminish the temperature of the skin. That is also why the laser fiber has to be in constant movement and care should be taken when treating areas near muscular sheath and near the skin (the former can cause rhabdomyolysis and postoperative pain and the latter can cause burn and necrosis). The laser fiber can be stopped at one place and more energy applied during few seconds if there is significant fibrosis and resistance. It is recommended to melt the deeper layer first followed with the superficial layer. When treating the pseudogynecomastia with some amount of ptosis, it is advisable to apply the energy on the breast but also around it-lateral chest and superior to the breast to induce the collagen formation and subsequent skin retraction (**Figure 1**).

Once the lysis is finished (no pop-corn sound, no resistance when passing the laser fiber, satisfactory pinch test), the standard suction is performed. Various reports exist on lysis only (without suction) but authors suggest to suction the melted fat whenever possible to avoid complications (contour irregularities, infection, seroma formation). The suction of the liquefied fat should be smooth without putting a lot of strain to the surgeon (there is no mechanical disruption of the fat). Pinch test should be performed to assess the amount of residual subcutaneous liquefied fat throughout the suctioning procedure (**Figures 2 and 3**).

In cases with skin laxity, additional pass of the laser fiber is performed at the end of the procedure in order to apply the energy on the remaining fibrous septa and the dermis to promote the collagen formation. If the laser beam is one-directional it can be rotated towards the skin (**Figure 4**).



Figure 1.
The arrows mark the area that should be treated with laser lipolysis only without subsequent suction to induce the collagen formation.



Figure 2.
Pinch test at the beginning of the suctioning.



(a)



(b)

Figure 3.
(a) Pinch test in the middle of the aspiration process with visible residual fat. (b) Pinch test at the end of the procedure.



Figure 4.
Directing the laser beam towards the skin at the end of the procedure.

Also, when performing high-definition laser-assisted liposuction, additional energy is applied on the previously marked muscle borders over the tendinous parts of the muscle to emphasize the muscular definition. Additional incisions for laser entrance are made if necessary.

Incisions can be closed with one suture or left open especially if treating larger amounts of fat to allow the drainage. If significant fluid leak is expected, penrose drainage can be placed on the incision site upon discharge.

Postoperative garments are of the utter importance in achieving the skin retraction and its good adaptation on the underlying surface. The authors suggest wearing postoperative garments for 3 weeks. Also, additional support is put over abdomen, male breast and/or flanks. That support should be made of not too rigid, yet flexible material that can be tailored upon every patient individually (between the ribcage and iliac crests) to minimize the dead space. To avoid ischemic complications of the skin, the sponge or cotton wool can be placed on its inner surface.) Those additional plates are put in place during the first postoperative week.

When performing high-definition laser assisted liposuction, adhesive bandages are placed on the tendinous parts of the muscles (were at the end of the procedure additional pass of the energy was applied to promote neocollagenesis). Those bandages are put in place for 7 days.

4. Results

Although there are many advocates for the use of laser assisted procedure only in certain indications, the authors always perform laser-assisted procedure. It is important to bear in mind that for the final result to be achieved, it could take up to 3 months due to the prolonged effect of the laser energy.

4.1 Body

4.1.1 Case 1

48-year-old female patient.

Procedure performed: laser-assisted liposuction of the abdomen, flanks, lower back and upper legs (**Figures 5–7**).

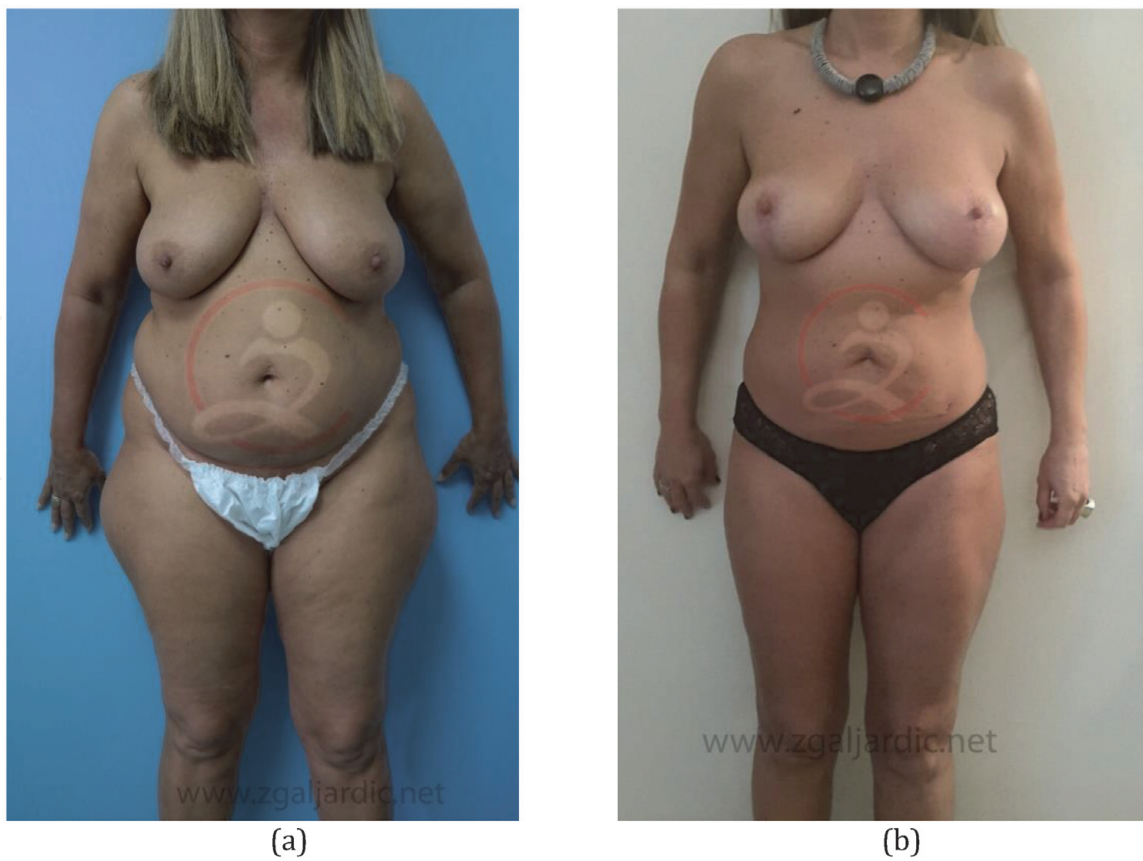


Figure 5.
(a) Before. (b) after 3 weeks.

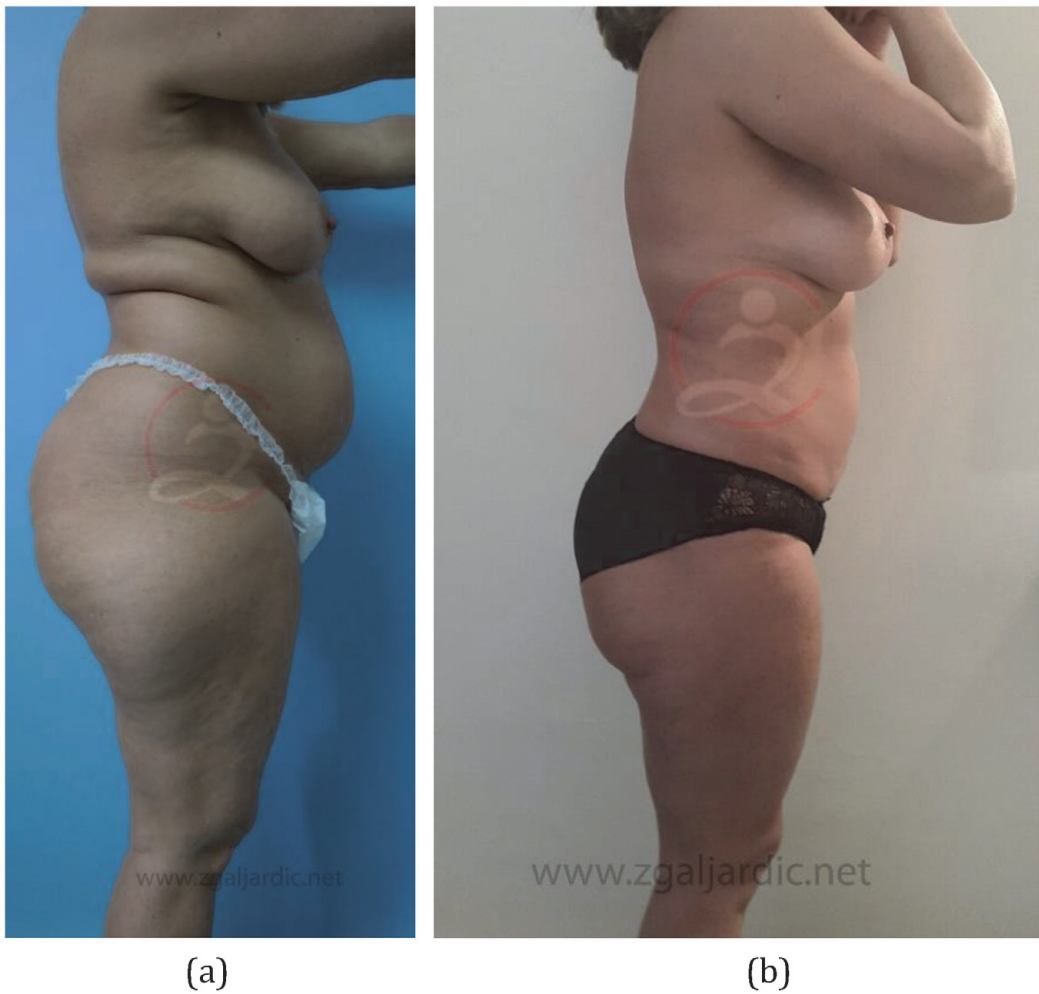


Figure 6.
(a) Before. (b) after 3 weeks.

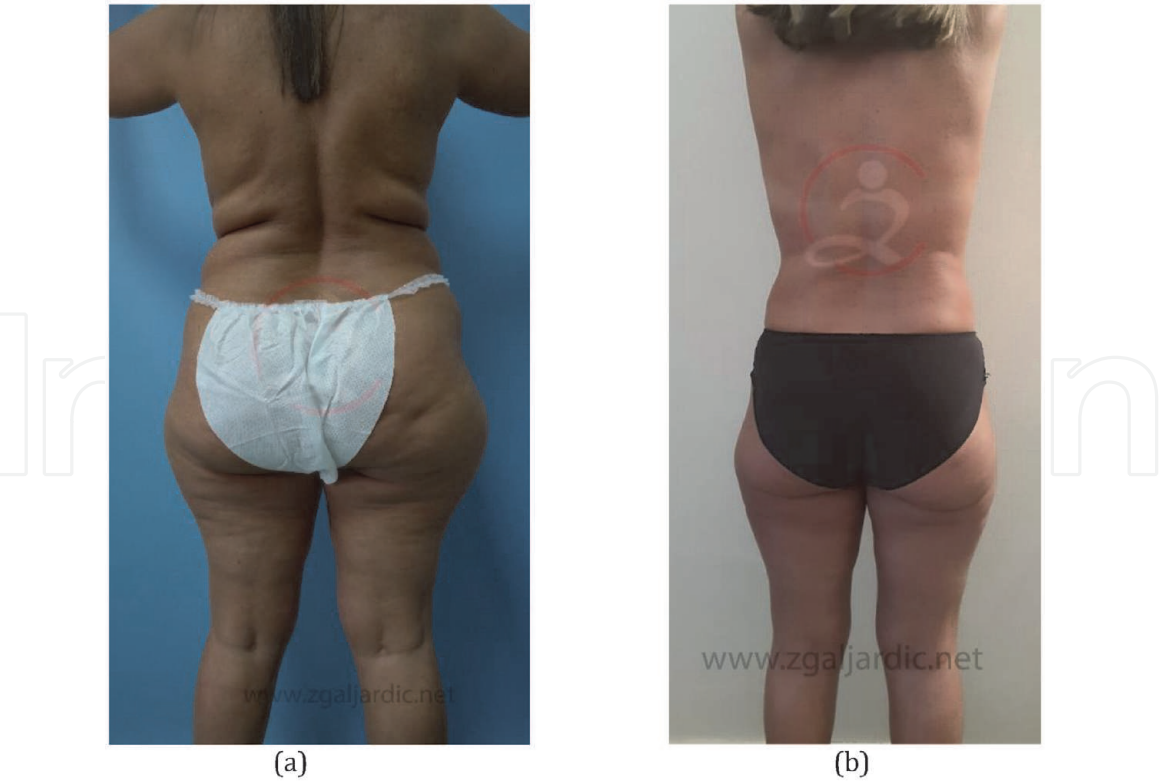


Figure 7.
(a) Before. (b) after 3 weeks.

4.1.2 Case 2

32-year-old female patient.

Procedure performed: laser-assisted liposuction of the abdomen, flanks, lower back and upper legs (**Figures 8–10**).

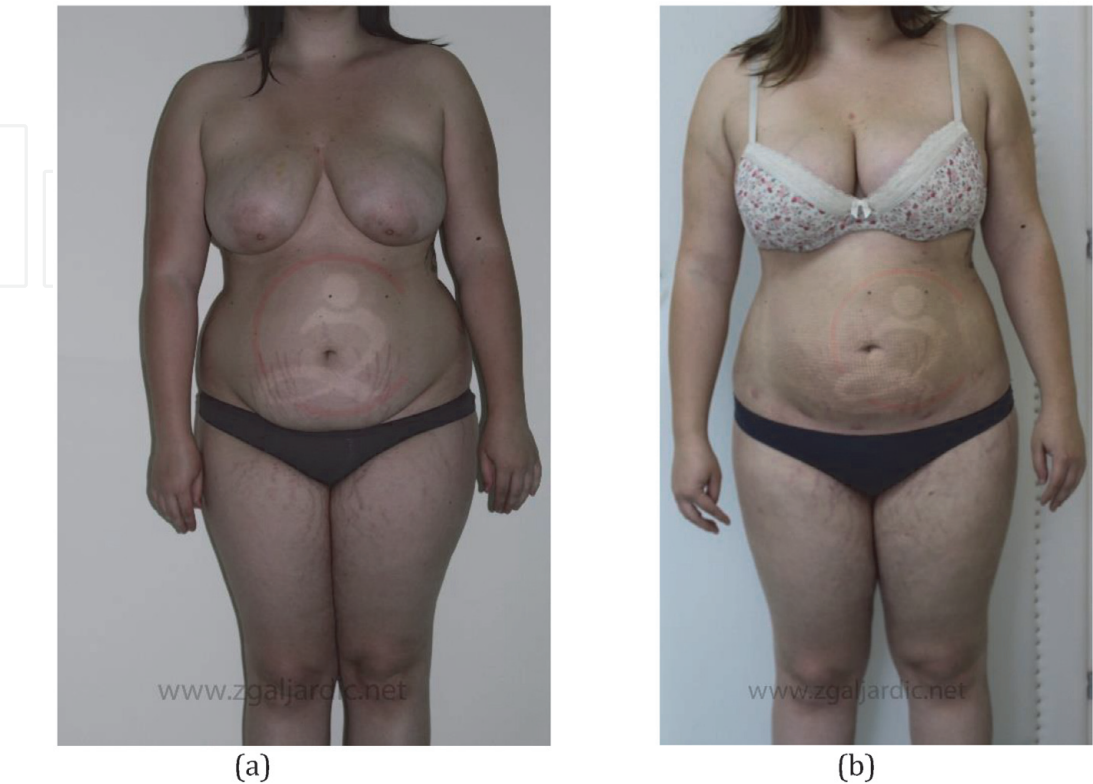


Figure 8.
(a) Before. (b) after 2 weeks.

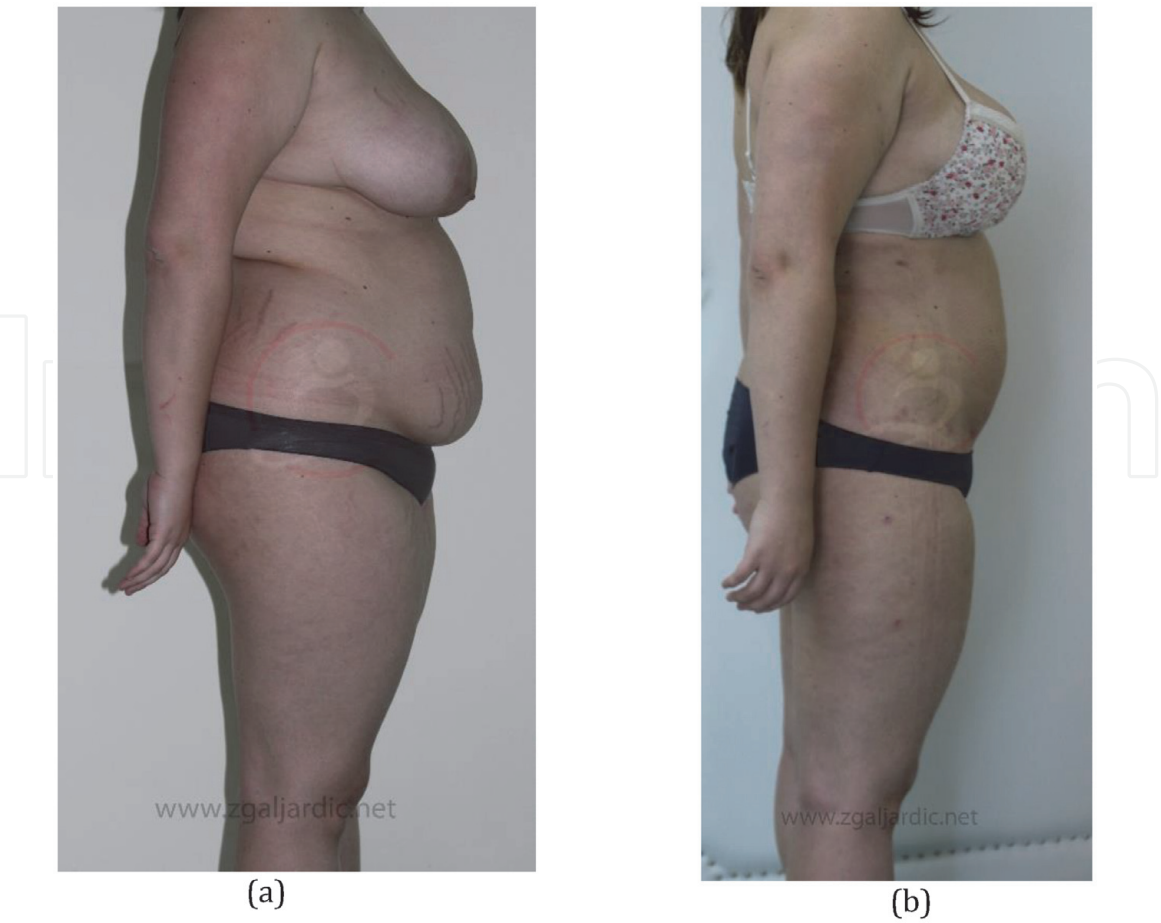


Figure 9.
(a) Before. (b) after 2 weeks.

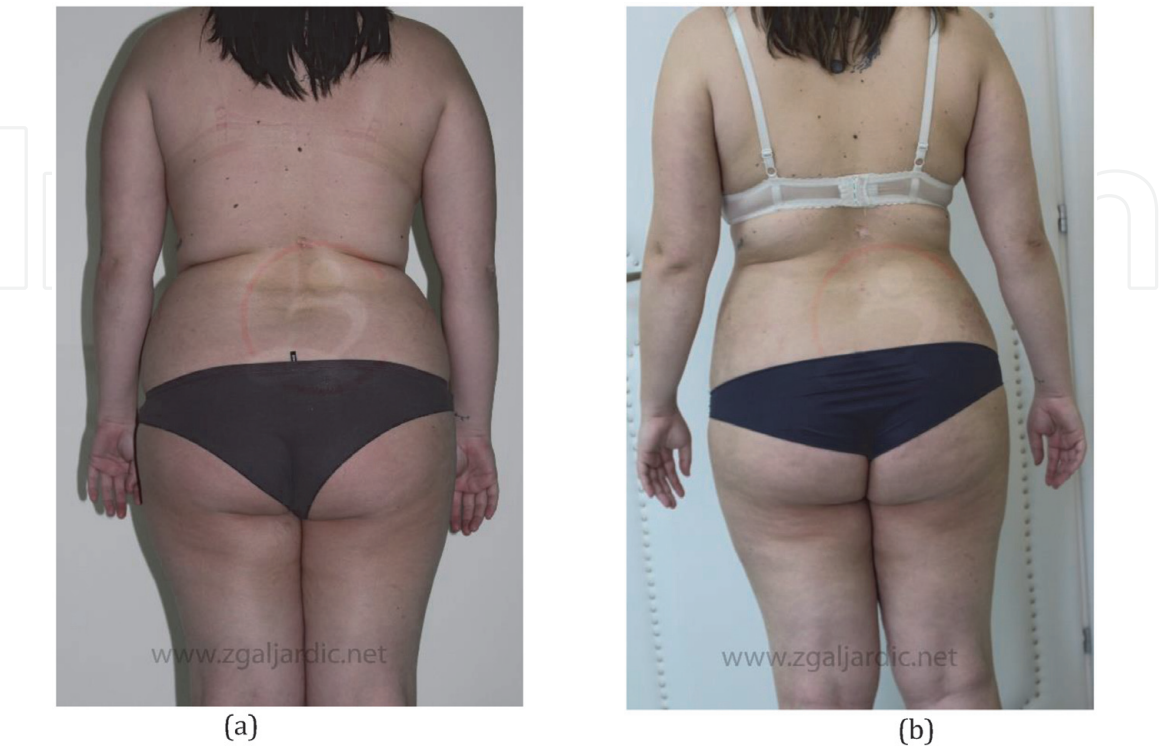


Figure 10.
(a) Before. (b) after 2 weeks.

4.1.3 Case 3

35-year-old female patient.

Procedure performed: laser-assisted liposuction of the abdomen, flanks, lower back and upper legs.

NOTE: few days prior to the procedure the patient went to the spray tanning salon (**Figures 11–13**).

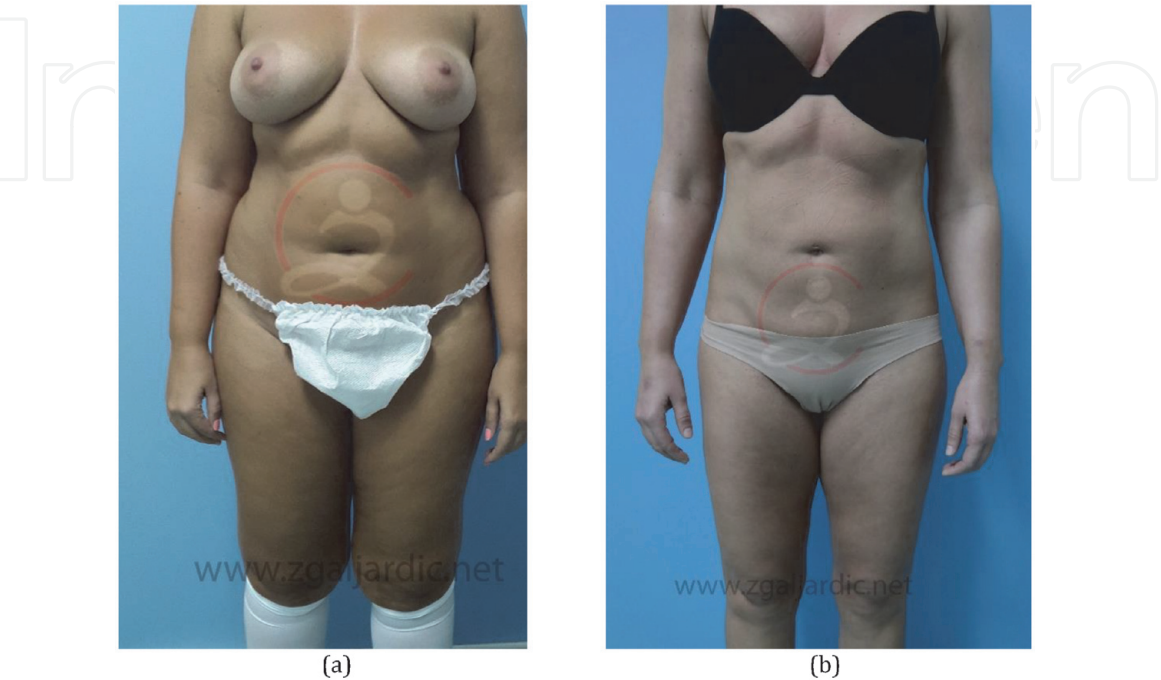


Figure 11.
(a) Before. (b) after 6 weeks.

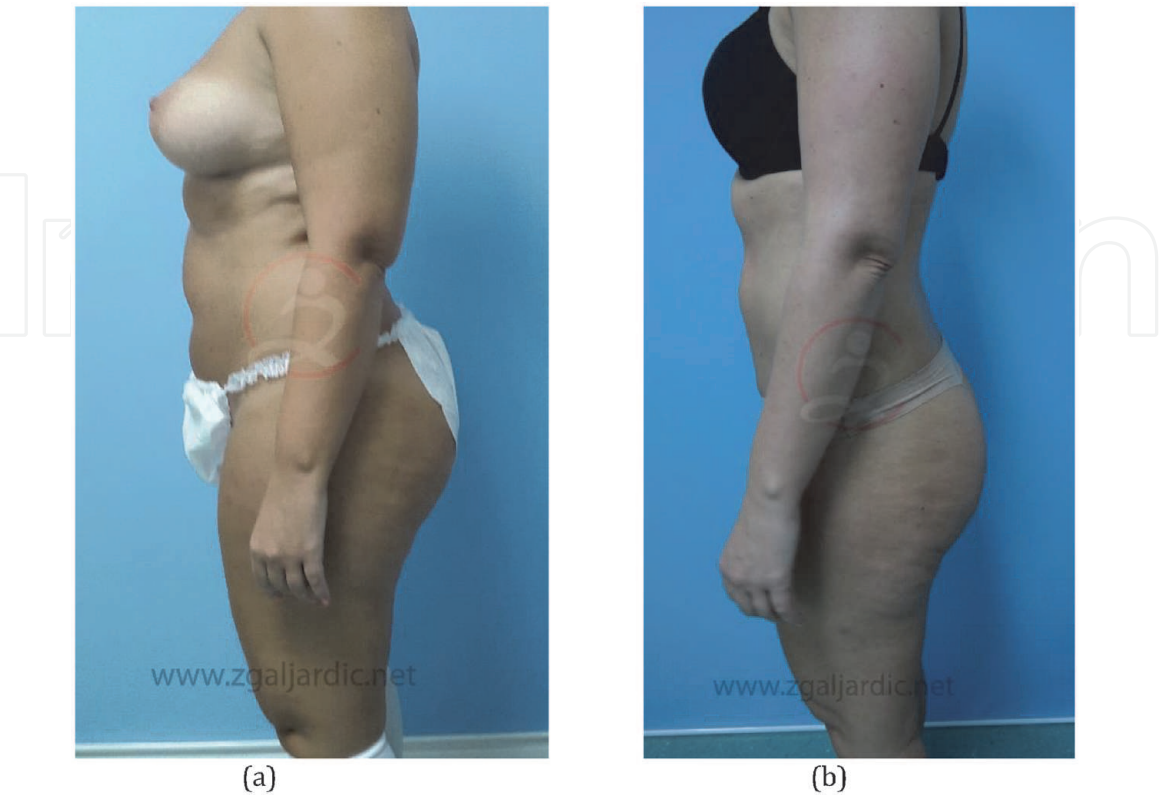


Figure 12.
(a) Before. (b) after 6 weeks.

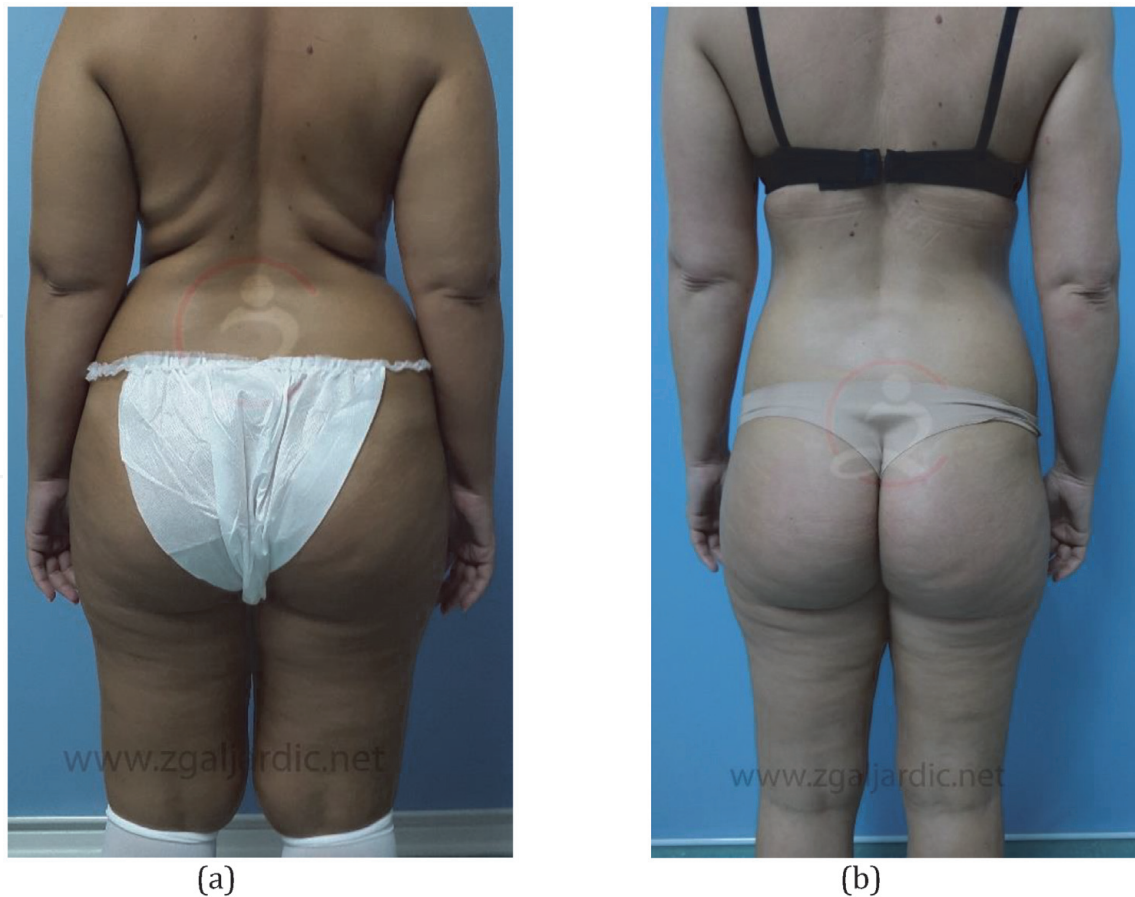


Figure 13.
(a) Before. (b) after 6 weeks.

4.2 Gynecomastia

Tips:

1. Infiltrate the larger area than the breast itself. Approximately 300-400 ml of tumescent solution should be infiltrated in each breast. Additional 100-200 ml should be infiltrated superiorly (up to approximately 5-7 cm below the clavicle) and laterally.
2. Perform laser lipolysis with subsequent liposuction of the breast. At the end of the procedure, perform laser lipolysis only (without liposuction) of the suctioned breast and surrounding area previously infiltrated in order to induce neocollagenesis in the fibrous septae and the superficial subcutaneous tissue. If the laser beam used is not multi-directional, rotate the tip of the laser beam towards the skin. Always control the surface temperature. If there is no internal thermometer, use the undominant hand to feel the surface temperature.
3. Apply maximal compression up to three weeks, especially during first 7 days. Compressive plates can be put in place below the garment and tailored individually. There are different types of compressive plates that can be found on the market. Compressive plates can be also individually tailored from the rubber mat used for exercise. In order to avoid ischemic complications from the pressure, a layer of cotton wool or gentle sponge can be put between the skin and the compression plate.

4.2.1 Case 1

43-year-old male patient.
Procedure performed: laser-assisted liposuction of the chest (**Figure 14**).

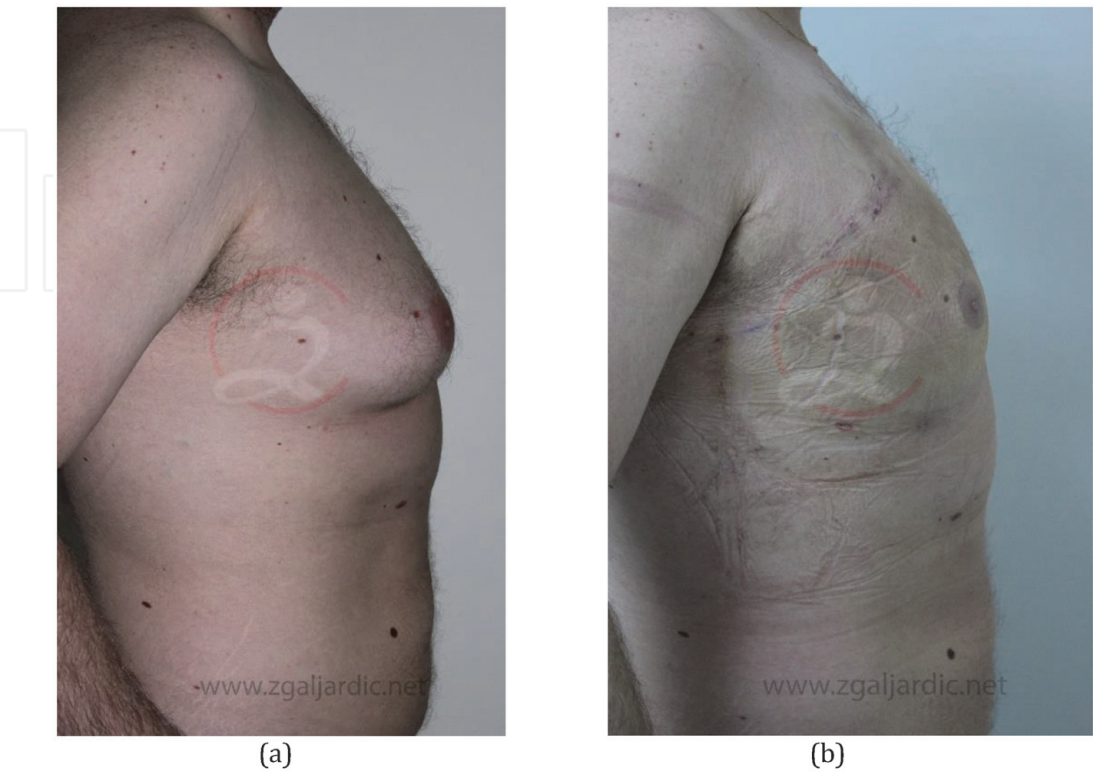


Figure 14.
(a) Before. (b) after 7 days.

4.2.2 Case 2

47-year-old male patient.
Procedure performed: laser-assisted liposuction of the chest (**Figure 15**).

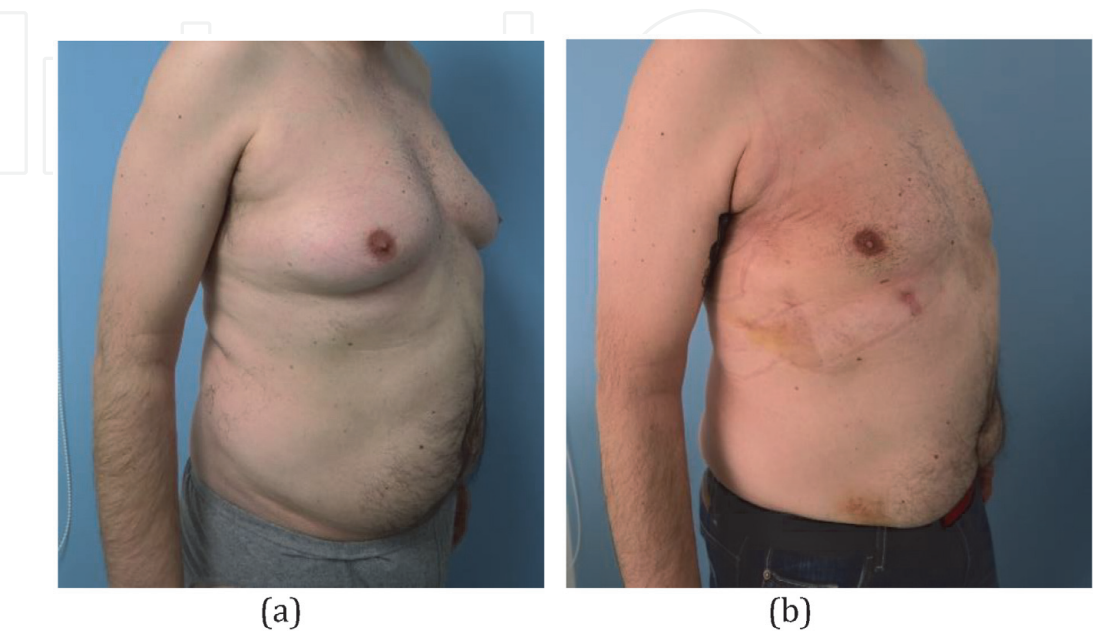


Figure 15.
(a) Before. (b) after 7 days.

4.3 High definition of the abdomen

Tips:

1. Before the procedure, mark the tendinous parts of the abdominal muscles.
2. After performing laser-assisted liposuction, additionally treat previously marked areas with laser energy only (laser lipoisys without liposuction) in order to induce neocollagenesis in the fibrous septae to mark the underlying muscles. If the laser beam used is not multi-directional, rotate the tip of the laser beam towards the skin. Always control the surface temperature. If there is no internal thermometer, use the undominant hand to feel the surface temperature. Make additional minimal skin incisions (for laser beam only) if the existing ones are not suitable.
3. Apply additional compression with adhesive bandages on the treated tendinous parts.

4.3.1 Case 1

24-year-old male patient.

Procedure performed: laser-assisted liposuction of the chest and abdomen (**Figure 16**).

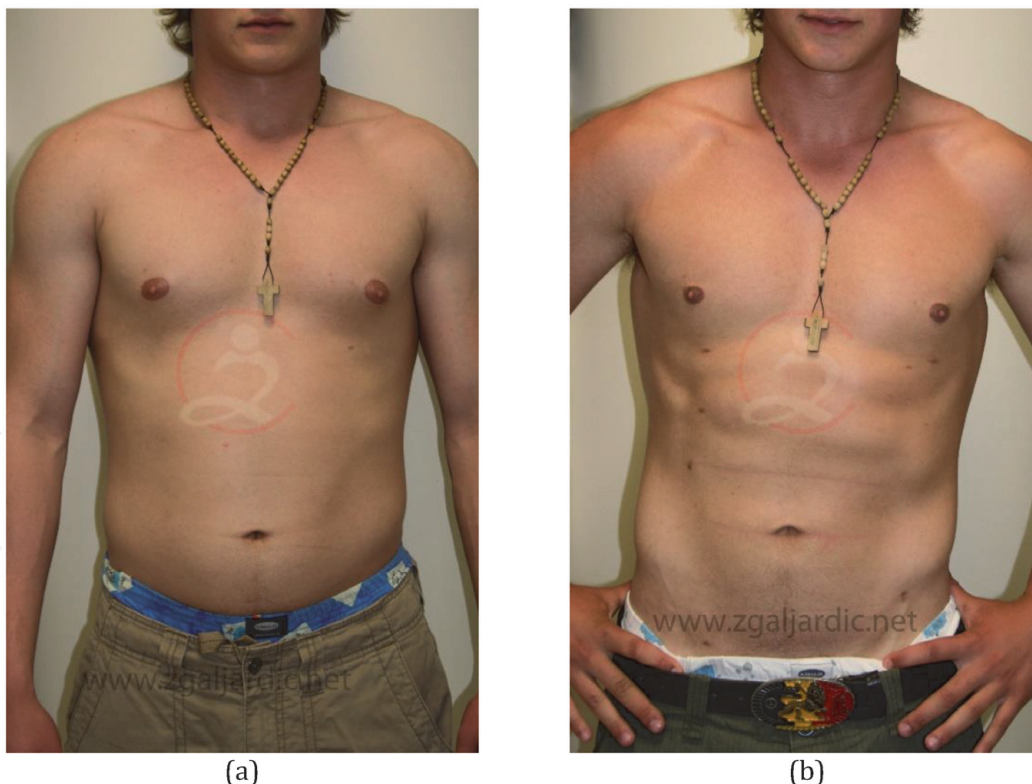


Figure 16.

(a) Before. (b) after 3 weeks.

4.3.2 Case 2

29-year-old male patient.

Procedure performed: laser-assisted liposuction of the chest and abdomen (**Figure 17**).

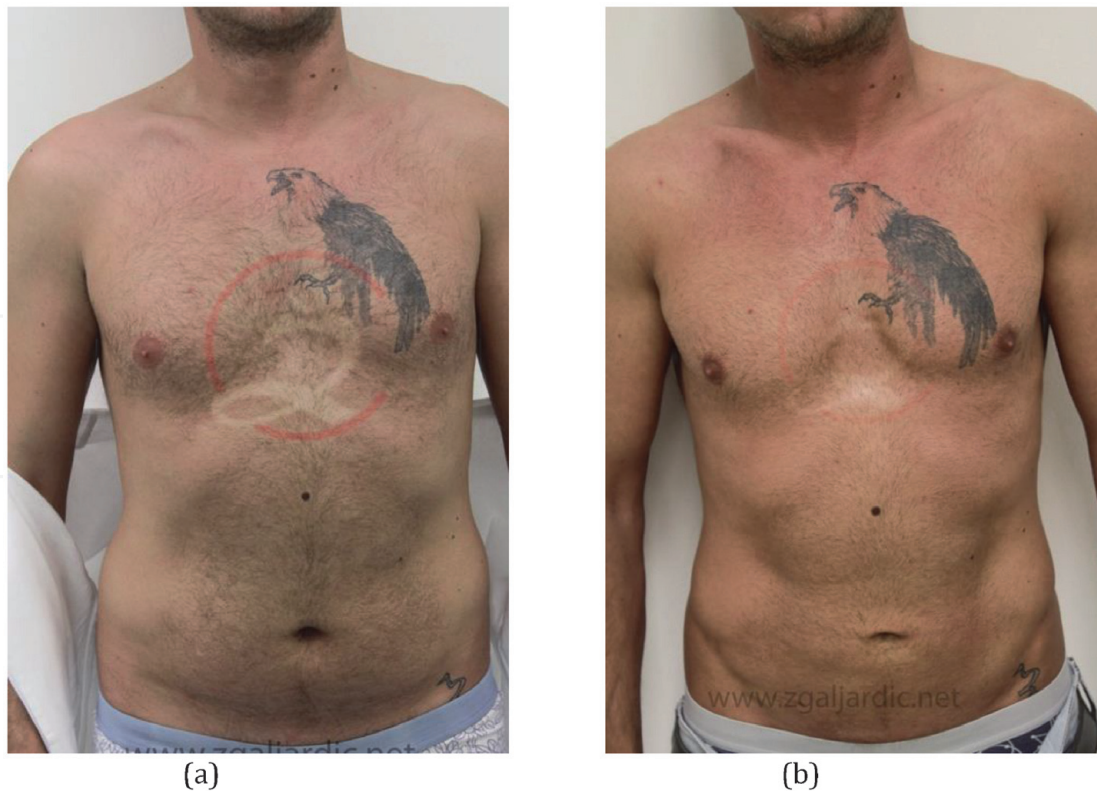


Figure 17.
(a) Before. (b) after 3 weeks.

4.4 Face

Tips:

1. Use lower energy than in the body (6 W) and discontinuous wave.
2. Infiltrate the subcutaneous submental area from jaw angle and the chin as a superior border below to the laryngeal prominence.
3. Use 2 mm or 3 mm cannulas for the liposuction
4. Apply additional laser energy after the liposuction if there is skin laxity or when performing the procedure as an endolight lifting only.
5. Put adhesive bandages above the treated area to promote skin retraction and to minimize the dead space.
6. Use commercial bandages for the face of wrap the bandage around the head for the first 7 days after the surgery and during the next 2 weeks advise patients to wear it over night.

4.4.1 Case 1

41-year-old male patient.

Procedure performed: laser-assisted liposuction of the submental area, lower jowls and neck (**Figures 18 and 19**).



Figure 18.
(a) Before. (b) after 3 weeks.



Figure 19.
(a) Before. (b) after 3 weeks.

4.4.2 Case 2

40-year-old female patient.
Procedure performed: laser-assisted liposuction of the submental area, lower jowls and neck (**Figure 20**).



Figure 20.
(a) Before. (b) after 1 month.

4.4.3 Case 3: patient treated solely for rejuvenation purposes- endolight lifting

50-year-old female patient.

Procedure performed: laser-assisted liposuction of the submental area, lower jowls and neck (endolight lifting) (**Figures 21 and 22**).



Figure 21.
(a) Before. (b) After 1 month.



Figure 22.
(a) Before. (b) After one month.

5. Discussion

The basis of laser-tissue interaction is considered to be the photo-thermal effect [6, 7]. The emitted laser light energy is absorbed by the tissue and converted into heat. When lower energy is applied, it changes the sodium-potassium balance on the cell membrane and promotes the cellular inflow of the extracellular fluid. On the other hand, when applying higher energy, membrane rupture occurs along with blood vessel and collagen coagulation [8]. For the latter to occur, internal subcutaneous temperature of 50°C should be achieved. Internal temperature should not exceed 65°C. That is considered to be critical end point temperature and higher temperatures lead to unwanted necrosis and subsequent scarring [6, 9]. DiBernardo and Reyes suggest that when performing superficial lipolysis to obtain skin tightening, the surface temperature should not exceed 47°C and should be limited to 42°C. The undominant hand should always control the surface temperature. That is why Mordon and Plot called the undominant hand, in this case, the “thinking” hand [10]. Different laser sources and wavelengths have been used for the lipolysis of the fatty tissue. Different wavelengths target different chromophore in the tissue so it has been hypothesized that specific wavelengths have better effect on fat disruption and other for skin tightening [11, 12]. Parlette and Kaminer reported that the 924 nm wavelength has the best fat absorption and thus, the highest fat melting potential [13]. On the other hand, there are authors that suggest that the heat and subsequently the histological damage and repair mechanisms are primarily responsible for the final result [14]. There are not many reports on the safety aspects of the applied energy. Reynaud et al. were the first to calculate the mean values of energy applied to different body areas in 2009. The machine used in their study was 980 nm diode laser. In their study conducted after 534 procedures were following: abdomen 24 600 J (6- 51 kJ), outer thighs 14 600 J (2.2- 31 kJ), waist 9 500 J (4- 19 kJ), posterior face of thighs 13 100 J (4- 25 kJ), inner thighs 10 400 J (4- 20 kJ), submandibular 11 700 J (6.6- 16 kJ), arms 12 800 J (4.7- 17 kJ), inner knees 8 100 J (2.7- 20 kJ), back 21 900 J (11- 35 kJ) [15]. In 2018, Ali published an article proposing parameters for safe and effective laser lipolysis. The average cumulative energy applied for each treated area were as follows: 2000-2500 J (chin), 8000-12000 J (arm), 5000- 6000 J (gynecomastia in each side), 4000-5000 J (flanks), 10000-14000 J (abdomen), 12000-18000 J (back), 8000-15000 J (saddle bags), 10000-14000 J (thigh and 800-2000 J (knees). The study was conducted on 300 patients using 2 different Nd:YAG machines with incorporated dual wavelengths of 1064 nm and 1320 nm (Smart Lipo triplex Cynosure and DaVinci model Quanta) [16]. There are no scientific data to support the thesis but in authors’ personal experience, larger amount of energy should be applied when working with diode laser. This observation is in concordance with the results of the previously mentioned studies. Mordon and Plot suggest that diode technology, in contract to Nd: YAG, has around 30% greater efficiency. They also suggest that higher wavelengths are better absorbed by fat and water therefore enable stronger heating. The latter, on the other hand, can increase the risk of thermal injury [10]. Wolfenson et.al suggest applying maximum of 5 kJ per 10x10cm of skin area treated in order to prevent complications of overheating [17].

Probably the greatest advantage of the laser-assisted liposuction is its ability to achieve significant skin tightening. Therefore, it is widely used in facial shaping, not just to achieve sculpting with fat removal but also to achieve rejuvenation effect. Given that, a term endolight lifting has been establish to describe the use of laser assisted liposuction as primarily rejuvenation procedure in the facial area. In 2011 Holcomb et al. have been first to publish the use of laser lipolysis on a larger series of patients. In total, 478 patients were treated with good final results [18]. In 2018,

Valizadeh et al. conducted a study on female patients seeking submental liposuction for fat reduction and skin rejuvenation. The patients were randomly assigned to two different groups: one treated with laser assisted liposuction and the other treated with traditional liposuction. The thickness of the submental fat was evaluated pre and postoperatively with ultrasound. The residual fat thickness was significantly lower in the laser assisted group at a 2 weeks follow-up with even greater difference at a 2 months follow up. Subjective patient evaluation was also performed using a subjective scale from 0 to 5. Patients treated with the laser assisted liposuction were considerably more satisfied than those treated with traditional liposuction in terms of fat reduction and final skin appearance [19]. On the other hand, many patients who are candidates for liposuction have some amount of skin laxity. This method offers excellent alternative for those where there is no clear indication for skin resection surgeries but are in higher risk in being left with some skin sagging after the procedure. There have been subjective reports on skin tightening after the laser assisted procedures but DiBernardo and Reyes were first to prove it in 2009 [9]. Several analysis and studies have been conducted to explain and measure the skin tightening effect. According to mathematical analysis and thermoregulatory measurement, internal temperature has to be between 48 and 50°C to obtain skin tightening effect [6, 20–22]. Although many reports exist and studies have been conducted, to date, there is no consensus on the amount of skin tightening that can be achieved and the indications are left to the surgeon's subjective opinion according to his or hers experience. Therefore, the drawback of this technique is the surgeon's learning curve.

Blood loss during the procedures significantly influences patient's recovery period. Many studies showed the superiority of laser-assisted liposuction over the standard tumescent technique regarding the diminished blood loss [9, 17, 23, 24]. Abdelaal and Aboelatta have conducted a prospective study to evaluate the amount of blood loss and have concluded that laser assisted liposuction can reduce the blood loss up to 50% comparing to the conventional liposuction [25]. The reduction of blood loss diminishes the risk of postoperative anemia and fatigue which significantly contribute to the patient's wellbeing through the recovery.

Various reports have also been published on the improvement of superficial skin irregularities such as cellulite. Petti et al. evaluated the cellulite improvement through the results on the modified Nurnberger-Muller scale 3-6 months after the laser assisted liposuction. An average improvement score was 1.58 on a scale from 1 to 3 suggesting significant satisfaction rate on the final esthetic appearance [26]. The authors have used laser-assisted lipolysis to treat skinny patient with localized cellulite with high satisfaction rate.

Disruption of the fatty cells with laser energy enables the use of cannulas of the smaller caliber. Thus, smaller entrance point can be made. Nevertheless, care must be taken not to injure the entrance site with laser energy. In that case, the resulting incision scar can be esthetically displeasing. In the same time, the procedure puts less strain on the surgeon as it is not his or her hand and mechanical manipulations responsible for the adipose cell disruption. The latter is also responsible for inflicting less trauma to the tissue that also contributes to the faster recovery. In a fibrotic area such as the male breast or the tissue that has previously been traumatized with liposuction, laser lipolysis is an excellent tool to melt the entrapped fat without additionally traumatizing the tissue. That is why laser assisted liposuction is an excellent tool in treating pseudogynecomastia or contour irregularities from previous surgeries.

The biggest disadvantage of the laser assisted liposuction is the possibility of the thermal injury, burn, necrosis and unwanted scarring. As previously stated, some

reports on safety protocols have been made and can be used as guidelines when implementing the laser in one's practice [15, 16]. Generally speaking, when internal subcutaneous thermometer is incorporated in the machine one can precisely measure the temperature and avoid overheating. Unfortunately, not all the devices come with that equipment. As already mentioned, cold compresses and external thermometer can be used to avoid placing too much energy in one spot. In authors' experience, the use of the undominant hand to control the skin temperature is the best tool to avoid the thermal injury. Also, when starting to implement this technique, lower power settings and discontinuous waves can be used to avoid complications. One should bear in mind that in this situation the energy is applied from under the skin so any postoperative blistering (if not caused by the outside pressure from the garment) will surely result in full thickness necrosis.

If laser lipolysis without subsequent suctioning is used, postoperative mass formation is possible that on histological analysis is described as fluid-filled pseudocyst with characteristics of foreign-body granuloma [27]. Given that, the authors advise suctioning the liquefied fat whenever possible. Last, but not least, when suctioning is performed, there is less swelling and the final result is achieved sooner. The latter, in the end, contributes to the overall patient's satisfaction.

Another drawback of this technique is the increase in the operating time. Prado reported in their study that average duration of traditional liposuction was 45 min and the laser assisted one- 60 minutes [28]. Although there is an increase in the operating time, the overall procedure, especially the suctioning is easier to carry out compared to the traditional liposuction.

One case of acute kidney injury due to rhabdomyolysis has been reported [29]. Hence, the surgeon should avoid injuring the muscle aponeurosis during the procedure. Nevertheless, in patients presenting with symptoms of acute kidney injury postoperatively, he or she should react accordingly.

6. Conclusion

Surgeons, as well as technological companies, are in constant search for the "holy-grail" of body contouring. Emerging technologies, as in this case, the use of lasers in body contouring procedures has made significant improvement on the final result, reduced recovery and thus, increased the patient's satisfaction. Not only that, the indications for the liposuction procedure have been widened.

Advantages:

- Skin tightening
- Reduced blood loss and faster recovery
- Treatment of cellulite and contour irregularities
- Less strain for the surgeon and diminished tissue trauma

Disadvantages:

- Risk of thermal injury
- Longer learning curve
- Increased operating time

Due to that, it has become possible to avoid skin excision both in body shaping and facial rejuvenation.

In conclusion, one should always bear in mind that every technology is only a tool in a surgeon's hand. Therefore, the experience of the surgeon is of the utmost importance.

Conflict of interest

The authors declare no conflict of interest.

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