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Nd:YAG Laser-Assisted Lipolysis

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Background

Liposuction is currently one of the most common cosmetic surgical procedures. Recently, lasers have been adapted for the treatment of localized fat. The author describes his experience in laser-assisted lipolysis using a 1064 nm Nd:Yag for laser lipolysis. In this procedure, lipodistrophy, the body and face can be treated with a neodymium, yttrium, aluminum, garnet (Nd:YAG) laser, at a wavelength of 1064 nm. The physical principles of laser action on the adipocyte and surrounding tissues, anesthetic details, application technique, cases, advantages, limitations, new indications, disadvantages, complications and long-term results are analyzed. Moreover, the principles of action of laser lipolysis represented by the thermal (photo-thermal effect) and the photomechanical effect on fat and adjacent tissues are demonstrated and analyzed by histological studies.

Treatment was 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, thereby expanding the adipocyte contents and rupturing the cell membrane. A photoacoustic effect may also play a role in cellular lysis, due to the rapid absorption by and heating of the cell.

The better knowledge of this kind of laser energy and its interaction with the tissues brought new medical indications and technical advances. Among them are stretch marks, cellulite, hyperhidrosis, bromidrosis, scars, as well as some vascular alterations. The device can be used as an isolated procedure or in association with other techniques.

Depending on the target or alteration to be treated, the laser beam acts in direct contact with internal tissues (fat or sweat glands) or is applied externally (striae, scars or vascular targets).

Methods

More than 3000 subjects were submitted to the 1064 nm Nd-YAG laser-assisted lipolysis between March 1999 and November 2006, at Clínica Goldman de Cirurgia Plastica, in Porto Alegre, Brazil. All underwent pre-operative assessment to determine their general medical condition. The main indication was in the treatment of lipodistrophy. All subjects provided informed consent. The procedure was recommended for patients with face or body lipodistrophy, yet without significant skin laxity.

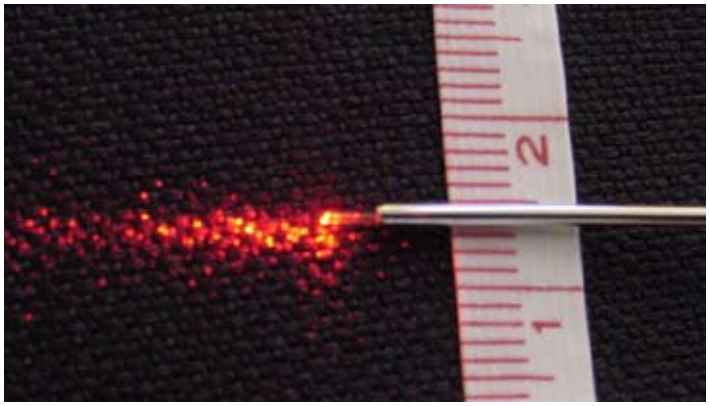

Fig. 1 – 1 mm cannula containing fiber optic extended approximately 2 mm from the distal end, and emitting laser energy. A reddish color from the Helium-Neon source can be observed.

The procedures were performed after subcutaneous infiltration of a Klein's solution or a similar warm solution containing normal saline solution, epinephrine and sodium bicarbonate. The total volume of the infiltration varied according to the treated area (30 cc to 3.500 cc). The procedure was initiated following a twenty minute delay, allowing for diffusion of the infiltrate and appropriate vasoconstriction. Practically all procedures were performed using local anesthesia or local anesthesia assisted by anesthetist. Histological studies were performed with the consent of the patient, focusing on the effects of the laser on the vessels, fat and dermis while using different colorations.

The laser system used is a pulsed 1.064 nm Nd:YAG system. This system provides ultra short pulses and has an extremely high peak power (up to 1,000 watts). In this procedure, the laser energy is conducted to the subcutaneous tissue through a 300-micron fiberoptic, delivered through a 1 mm diameter stainless steel micro-cannula of variable length. A 150 µs pulsed laser at 40 Hz and 150 mJ (working at 6 W) was used for all patients. The distal portion of the fiber optic is extended 2 mm beyond the distal end of the cannula. For visualization purposes, a He:Ne laser source is combined into the beam path to provide an exact view of where the laser is working once the positioning of the cannula is highlighted via trans-illumination of a red guiding beam. A 1 mm incision is enough to introduce the cannula, which is then moved in the fat tissue at various depths, including the sub dermal layer, similar to a superficial liposuction.

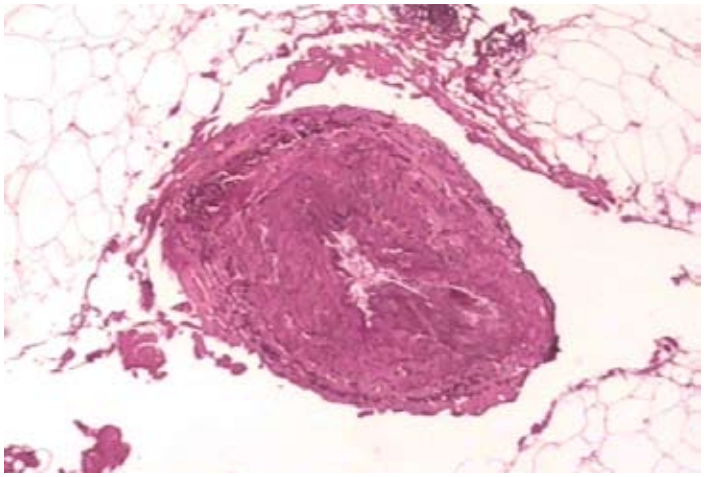

Fig. 2 – Histology showing coagulation of small blood vessels in fat tissue by means of laser action (Orcein 32x).

The photomechanical and the thermal effects play an important role in cellular lysis. The adipocyte membrane is ruptured under rapid absorption by and heating of the cell. The laser treatment is delivered over a varying length of time, and total deposited energy (accumulated energy) goes according to the size of the treated area, and tissue resistance. The product of the cellular lysis is usually removed using negative pressure of around 350 mm Hg to 450 mm Hg in conjunction with a 2.5 mm suction cannula. It is an outpatient procedure and after the first post-operative day the patients gradually

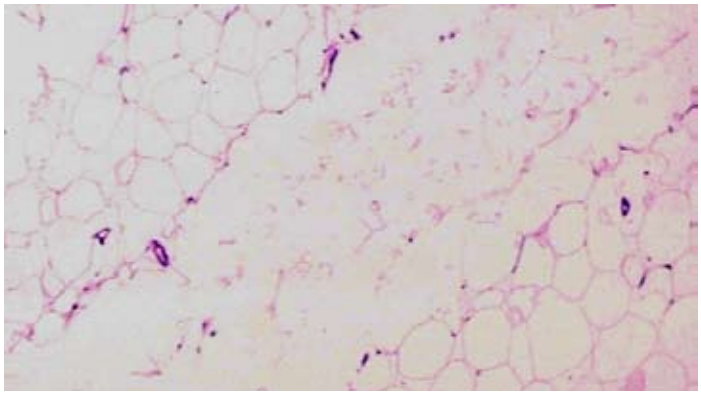

Fig. 3 – Channel produced by 1064nm Nd:YAG laser, showing the rupture of adipocytes and fragments of adipose cell membranes (Hematoxylin eosin 32x).

returned to normal daily activities, typically with little discomfort. A smooth compression was used for one week.

Complications included some cases of asymmetry, hyper and hypo correction. No cases of infection, cellulite or other complications were observed in this series. The careful and judicious selection and preparation of subjects, technical knowledge as well as proper subject orientation were essential for the success and safety of the procedure.

Histological Studies and Results

Significant findings following laser lipolysis included the coagulation of small blood vessels in the fatty tissue, cellular lysis, the appearance of small channels produced by laser action, the reorganization of the reticular dermis and the coagulation of collagen in the fat tissue. Although the final result obtained with laser lipolysis was similar to the author's experience with traditional liposuction methods, the histological findings suggest several positive benefits brought by the use of the Nd:YAG laser, which include skin retraction due to new collagen formation, and a reduction in perioperative and postoperative bleeding as well as in the population of adipocytes. No anatomical nerve alterations were observed in the histological studies developed by Blugerman and Schavelzon. Complications were similar to those found with other lipoplasty methods and, in the author's experience, there were no side effects directly related to the laser use.

Discussion

The 1064 nm Nd:YAG laser in laser lipolysis proved to be a safe and effective method with low blood loss, a low rate of ecchymosis and little discomfort in the post-operative period. The treatment of areas that traditionally pose greater difficulty in removing fat, such as the dorsal regions or breasts, in gynecomastia, is made easier, as the microcannula with the laser has a diameter of only 1 mm, and penetration is made easier by action of the laser energy. The decrease in tissue trauma is likely to be associated with the laser-induced coagulation of small vessels in the fat tissue, the adequate infiltration of the anesthetic solution and the possibility of using smaller caliber cannulas. This also requires less effort which results in less fatigue for the surgeon. This facilitating effect is also observed in previously operated areas. The observation of a reddish color from the Helium-Neon source, due to transillumination, makes the procedure quite accurate, as it allows the surgeon to identify the exact place where the tip of the microcannula is and where the laser is working. Histological studies have shown positive effects as in the coagulation of small vessels, rupture of adipocytes, reorganization of reticular dermis and coagulation of fat collagen.

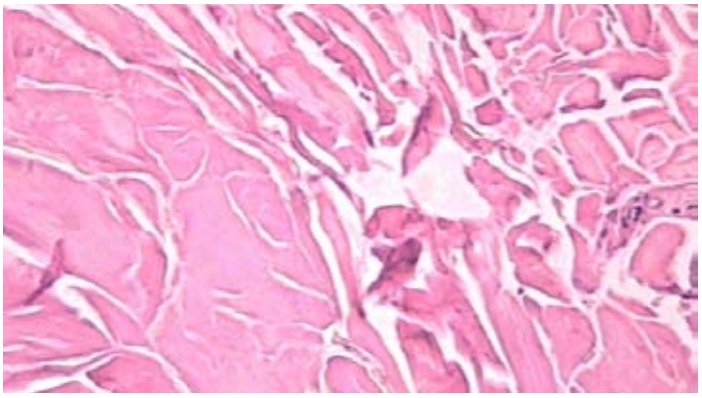

Fig. 4 – Collagen Coagulation (Hematoxylin eosin 100x).

The effect of small vessel coagulation would corroborate to less ecchymosis in the post operative period. Collagen coagulation with a consequent neocollagenesis effects which have already been observed with other types of laser, would contribute to adequate skin tightening.

The potential to use the laser for superficial treatments may represent another option for the treatment of cellulite, remodeling collagen and smoothing the treated area. Although the positive effects were observed by the author and reproduced by many authors in many scientific publications, more studies and follow-ups are needed in order to deeply determine the characteristics and effects of this method.

Conclusions

The histological findings and long-term postoperative clinical outcomes of subjects who underwent laser lipolysis of the face and body have proven the safety and effectiveness of this procedure.

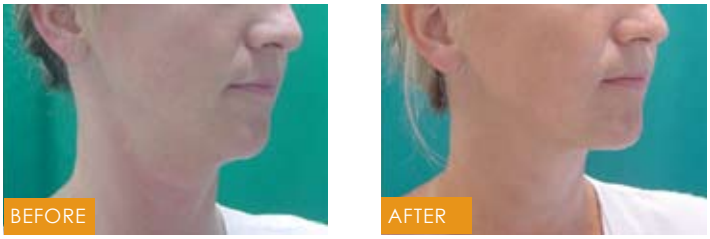

Fig 5 – A 37-year-old patient with submental treatment. Result after 4 months.

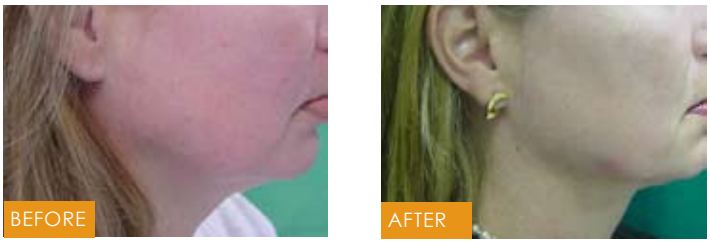

Fig. 6 – A 47-year-old woman with submental lipodistrophy. (Left). Preoperative view. (Right). Postoperative view after 42 months. Note the improvement of the mandibular contour.

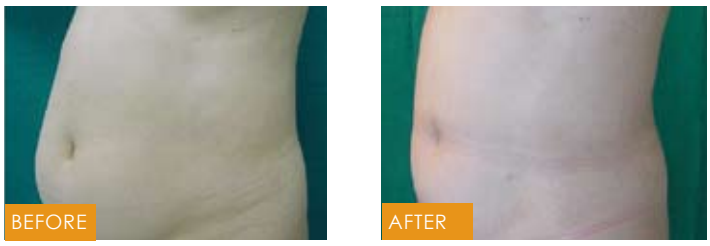

Fig. 7 – A 50-year-old patient (Left). Preoperative view. (Right). Postoperative view after 5 months.

Fig. 8 – A 26-year-old patient who underwent laser-assisted lipolysis on the abdomen and flanks. (Left) Preoperative views. (Right) Post-operative views after 3 months.

Fig. 9 – A 21-year-old woman hips treatment.

Fig. 10 – A 40-year-old man (Left). Postoperative view after 16 months. Laser lipolysis was performed in abdominal region, flanks and breasts (gynecomastia treatment).

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