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ORIGINAL ARTICLE

Laser-assisted lipolysis in the treatment of gynecomastia: a prospective study in 28 patients

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Abstract Gynecomastia is the most common breast pathology. Numerous excisions and liposuction techniques have been described to correct bilateral male breast enlargement. Recently, there has been a shift from the open approach to minimally invasive techniques. This article reports a 5-year experience using laser-assisted lipolysis (LAL) to treat gynecomastia, and describes the surgical technique. Between January 2006 and December 2010, a total of 28 patients with bilateral gynecomastia were treated with LAL. Patients had a mean age of 36.5 years (range 24 to 56 years). LAL was performed with a 980-nm diode laser (continuous emission, 15 W power, 8–12 kJ total energy per breast) after tumescent anesthetic infiltration. The breast was evaluated objectively by two physicians who compared chest circumference and photographs. Patients were also asked to score the results using a visual analogue scale: 75 to 100 (very good), 50–74 (good), 25 to 49 (fair) and 0 to 24 (poor). The postoperative period for all patients was incident-free. After 6 months, 18 patients (64.3%) scored the results as "very good", 6 as "good" (21.4%), 3 as "fair" (10.7%) and 1 "poor" (3.6%). Mean chest circumferences pre- and postoperatively were, respectively, 117.4±11.1 cm and 103.3±7.5 cm ($p<0.001$), corresponding to a mean difference of 14.1 cm. Physicians scored the photographs as "very good" in 22 patients (78.6%), as "good" in five patients (17.9%), and as "fair" in one patient (3.6%). LAL in gynecomastia is safe and produces significant effects on fatty tissue, with a reduction in breast volume, together with significant skin tightening. Provided an appropriate amount of energy is delivered by an experienced operator, the results are both significant and consistent.

Keywords Gynecomastia · Laser · Laser-assisted liposuction · Laser lipolysis · LAL

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Introduction

Gynecomastia, from the Greek words 'gyne' for woman and 'mastos' for breast, was first described by Paulus Aegineta (625–690 AD) [1]. An estimated 32% to 65% of males are affected by the condition, from over-feminization of the chest to moderate excess [2,3]. Gynecomastia can be fatty (also called pseudogynecomastia), glandular, or mixed. The most commonly used clinical classification for gynecomastia was proposed in 1973 by Simon et al. [2] (Table 1). However, new classifications have attempted not only to describe the pathology, but also to standardize the treatment [3, 4]. Medical treatment may be effective at an early stage of proliferation. With time the tissue will become fibrotic

Table 1 Classification of Simon et al. [2]

Grade	Clinical appearance
I	Minimal enlargement without skin excess
IIa	Moderate enlargement without skin excess
IIb	Moderate enlargement with skin excess
III	Marked enlargement with significant skin excess

and thus fail to respond to medical therapy. Surgical procedures should target four main characteristics: (1) excess breast, (2) excess skin, (3) areola dystopia/enlargement, and (4) histological assessment in those with suspicion of cancer [3–7]. Conventional liposuction, using assisted aspiration and cannula vibration (accompanied by ultrasound or not), is considered the surgery of choice for gynecomastias with predominant fatty tissue, in the absence of any suspicion or risk of cancer. If the tissue is fibrotic, it can be eliminated via incisions, and, as reported recently, by using a cartilage shaver [8]. Nevertheless, it is the skin excess that determines the success of surgery, and the esthetic acceptability of the result in terms of a natural shape and conformation to the pectoral muscle region. Laser-assisted lipolysis (LAL), introduced by Apfelberg in 1996 [9], has the advantages of (1) excellent patient tolerance, (2) quick recovery time, and (3) the additional benefit of dermal tightening. Reported here is a prospective study representing our experience of LAL in gynecomastia and the numerous advantages of this technique.

Material and methods

Patients

The clinical study protocol was reviewed and approved by the Ethics Committee of the Antoni de Gimbernat Foundation. Enrolled in the study were 28 patients aged between 24 and 56 years (average 35.5±9.1 years) with long-term gynecomastia. They signed an informed consent for the study and surgery. The increase in breast tissue had been progressive, asymptomatic and bilateral. Without exception, all patients expressed psychological distress as a result of their gynecomastia. Anamnesis was unremarkable and none of the patients had a history of substance abuse as a possible cause of their gynecomastia. Physical examination identified 16 of the 28 patients (57.1%) as being overweight with a high body mass index as shown in Table 2. Analysis showed normal levels of estradiol, testosterone, luteinizing hormone/follicle-stimulating hormone and human chorionic gonadotropin in all patients. Hepatic, renal and thyroid laboratory tests showed no abnormalities, and chest plain radiographs and mammograms appeared normal. After ruling out gynecomastia of pharmacological origin, and having assessed the state of evolution of fibrosis of the gynecomastia in all patients, surgery was indicated to reduce breast volume with laser-assisted liposuction.

Breasts

Gynecomastia was assessed using the classification of Simon et al. [2] (see Table 2). The mean time between the onset of breast enlargement and the procedure was 11 years. Mammary tissue was predominantly fibrotic, well-defined, and with an average size of 8×20 cm. This measurement was taken from the x and y axis of the breast, respectively, with the patient in a standing position. Flaccid skin was present in all patients, but more evident in 12 of the 28 patients. Asymmetry was present in 9 of the 28 patients. With the patient in a standing position, the pectoral area was marked to define the boundaries for liposuction, taking into account possible asymmetry in order to correct it with LAL and suction at the time of surgery. The upper and lower breast pole borders were drawn out, and the inferior breast fold was marked 3 cm below its normal location. Also, the areola/nipple complex was marked so that it could be protected during surgery.

Laser-assisted lipolysis

In all patients, tumescent anesthetic was injected (Klein formula; 0.1% lidocaine and 1:1,000,000 epinephrine) [10]. The amount of anesthetic was never less than 500 ml per breast, and all patients were lightly sedated with midazolam under the supervision of an anesthesiologist. Then 15 min after the anesthetic injection, two 2-mm incisions were carried out with a no. 11 scalpel (Fig. 1). A 1-mm diameter, 9-cm long blunt 16G cannula was introduced in order to carry out tunneling maneuvers. If the breast had a conical form with hard tissue consistency, a Toledo cannula was first used to break down fibrotic bridges. Then, the 600-μm laser fiber cannula was introduced (Fig. 1). The fiber was adjusted so as to protrude from the tip of the cannula by approximately 5 mm (Fig. 1). The system used was a 980-nm wavelength diode laser (Quanta C D-Plus 980 diode laser, Solbiate Olona, Italy) at a power of 15 W with continuous emission, and 8–12 kJ total average accumulated energy per breast. The total exposure time depended on the gynecomastia volume. Laser energy emission was directional following the plane of the cannula. Care was taken that the cannula was moved back and forth in two fat tissue planes whenever the laser was actuated. First, the cannula was passed in a deep plane, followed by a faster movement in a more superficial skin layer. The aim was to

Table 2 Patient demographics

Patient	Age (years)	Overweight	Gynecomastia grade[a]	Duration of gynecomastia (years)	Asymmetry	Body mass index (kg/m^2)
1	39	Yes	III	8	No	28
2	28	Yes	III	4	No	29
3	36	No	III	17	Yes	24
4	24	No	III	6	No	23
5	28	No	III	4	Yes	21
6	33	No	IIb	11	No	21
7	47	No	III	16	No	25
8	49	Yes	III	12	Yes	30
9	25	No	III	15	No	24.5
10	27	Yes	III	10	No	28
11	29	No	III	8	No	24
12	35	Yes	III	12	No	28
13	41	No	III	16	No	32
14	48	Yes	III	15	Yes	35
15	36	Yes	III	10	No	30
16	56	Yes	IIb	22	No	29
17	24	No	III	6	Yes	25
18	25	Yes	III	5	No	27
19	51	Yes	III	20	No	30
20	28	No	III	7	Yes	24
21	31	No	III	7	No	25
22	36	Yes	III	10	No	27.5
23	39	Yes	III	16	No	29
24	43	Yes	III	13	Yes	29
25	26	No	IIa	4	Yes	22
26	28	No	III	3	No	24
27	37	Yes	III	13	Yes	32
28	44	Yes	III	18	No	36

[a]According to the classification of Simon et al. [2].

achieve build-up of thermal effects and heat propagation as homogeneously as possible in the dermis. Care was taken not to stop the movement of the cannula, and to maintain coordination between laser emission and movement of the arm back and forth. If the cannula was stopped and irradiation was continued, there was a risk that the skin surface would burn. When acting on a superficial plane, hand movements were careful and quicker in the areola/nipple complex area to avoid damage of the vascular pedicle. In patients with asymmetric gynecomastia, extra passes of the laser cannula were carried out in the contralateral breast. In these patients, extra energy of 1–2 kJ was delivered. After the procedure, aspiration was performed at 1 bar negative pressure with the 1-mm cannula previously used for tunneling using a liposuction suction device (LIPO MR; Ordisi, Barcelona, Spain). After aspiration, manual examination was carried out to detect possible irregularities in the breast shape. Incisions were sutured with a single 4/0 nylon stitch. No drainage was used. A wide elastic compression dressing (Omnifix elastic; Paul Hartmann, Heidenheim, Germany) was applied.

Temperature control

A cooling device (Cryo V; Zimmer, Ulm, Germany) with a continuous flow of cold air at a rate of 600 l/min at −20°C was used during the procedure. Changes in skin temperature were constantly monitored externally with an infrared thermometer (laser infrared thermometer, Center 350; Center Technology, Taiwan). Temperatures never exceeded 42°C. If this temperature was approached, the cannula was moved to another area to prevent skin burning.

Postoperative care

A compression bandage (Banda torácica, VOE 4005; VOE, Barcelona, Spain) was placed over the dressing. The dressing

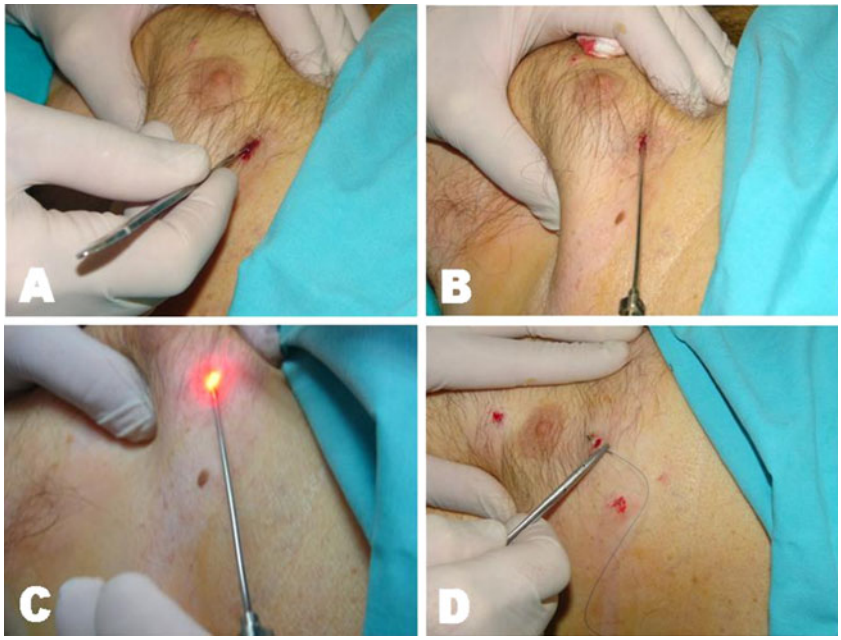

Fig. 1 Surgical technique: **a** 2-mm skin incision; **b** 9-cm long blunt 16G cannula is used to carry out the tunneling maneuvers; **c** the cannula with a 600-μm laser fiber is introduced to perform LAL; **d** skin suture at the end of the procedure

was kept in place constantly for 7 days. An elastic compression garment was then kept in place continuously for an additional 20 days, being removed only for hygienic purposes. After this time the garment was worn only at night for 30 days. Follow-up examinations were performed at 24 h, 7, 15 and 30 days, and 2 and 6 months. All patients received physiotherapy sessions including manual lymphatic drainage. These sessions were carried out once a week for a total of 6 weeks and began once the dressing was removed at 7 days. Patients were advised to complement these physiotherapy sessions with light exercises so as to maintain the tone of the pectoral muscles. An assessment of the improvement was done at the last visit, 6 months after surgery. Prednisolone (30 mg per day), paracetamol (650 mg every 6 h) and amoxicillin/clavulanic acid (500 mg three times daily) were prescribed on postoperative days 3, 4 and 6, respectively.

Patient subjective assessment

Patients were asked to score the results using a visual analogue scale: 75 to 100 (very good), 50–74 (good), 25 to 49 (fair) and 0 to 24 (poor). A space was left on the form for patients to comment on the perceived improvement compared to before LAL.

Objective assessment

Results were also evaluated objectively first by comparing the chest circumference and second by comparing the photographs. Chest circumference was measured before surgery and at the last visit 6 months after surgery. Chest circumference was always measured at a standard height using a tape measure at the level of the nipples with the patient standing and in expiration. To compare photographs, two independent physician evaluators were presented with photographs taken before and 6 months after surgery. If the two evaluators did not agree, consensus was reached after speaking to one of the surgeons. Objective assessment used the same scoring system as the subjective assessment. Scores were plotted on a graph and the physicians had the chance to comment.

Statistical analysis

This prospective study included 28 patients with bilateral gynecomastia who were compared before and 6 months after LAL. Statistical analysis was done using the XL Stat program (Addinsoft). The different measurements are presented in Tables 2 and 3. Data are presented as means and standard errors of the means (SEM). Student's *t*-test (two-sample) was used to calculate the *p*-values and $p < 0.05$ was considered statistically significant.

Results

Complications

The postoperative period in all patients was incident-free. Pain was well controlled with paracetamol. Most discomfort was felt when moving the arms, especially when lifting relatively small weights. There were no signs of ischemia, areola congestion, skin burning, or loss of sensation in the nipple. There was a slight darkening from bruising, which

Table 3 Breast assessment at 6 months

Patient no.	Patient subjective assessment					Chest circumference (cm)		Physician objective assessment				
	Very good	Good	Fair	Poor	Remarks	Before	6 months after LAL	Very good	Good	Fair	Poor	Remarks
1		x				128	116	x				
2	x					124	106	x				
3			x		Asymmetry before	133	111			x		Asymmetry corrected
4	x					120	103	x				
5	x				Asymmetry before	102	94	x				Asymmetry corrected
6	x					104	97	x				
7		x				121	112	x				
8		x			Asymmetry before	129	110		x			Asymmetry corrected
9	x					101	93	x				
10			x			132	118		x			
11	x					114	99	x				
12		x			Asymmetry before	128	107	x				Asymmetry corrected
13	x					110	98	x				
14	x				Asymmetry before	122	111	x				Asymmetry corrected
15	x					118	104	x				
16	x					115	102	x				
17		x			Asymmetry before	120	104		x			
18	x					132	106	x				
19	x					110	97	x				
20			x		Asymmetry before	126	105		x			Asymmetry corrected
21		x				116	101	x				
22	x				Asymmetry before	106	98	x				Asymmetry corrected
23	x					110	95	x				
24	x					98	89	x				
25	x					96	91	x				
26				x	Asymmetry before	134	110		x			
27	x					116	108	x				
28	x					122	106	x				

had resolved in all patients by the 15th postoperative day. Sutures were removed 7 days after surgery, and no infection, seroma or scarring was noted.

Subjective evaluation

Table 3 shows the subjective and objective results for all patients at the 6-month assessment point (Figs. 2 and 3). Combining the "very good" and the "good" scores, the treatment was successful both from an esthetic standpoint and in terms of anatomical reshaping of the pectoral region. Only 1 month after surgery patients began to notice a reduction in breast size and skin tightening. At 6 months, 18 patients (64.3%) scored the result as "very good", 6 as "good" (21.4%), 3 as "fair" (10.7%) and 1 as "poor" (3.6%). The three patients scoring the result as "fair" complained that the reduction in breast volume was less than their expectation. The patient who scored the result as "poor" reported a slight asymmetry, a perception that was in accordance with the physician score. This patient requested a touch-up which was carried out, but he continued to assert that his expectations had not been met.

Objective evaluation

Mean chest circumferences pre- and postoperatively were respectively 117.4±11.1 cm and 103.3±7.5 cm ($p<0.001$), corresponding to a mean difference of 14.1 cm. Before treatment only two patients had a chest circumference less than 100 cm and both of these patients scored the result as "very good", which agreed with the evaluators' scores. Physicians scored the photographs as 'very good" in 22 patients (78.6%), "good" in 5 (17.9%), and "fair" in 1 (3.6%). Progressive improvement was noted at the various postsurgical visits with a smooth reduction in edema and pectoral projection. It was not possible

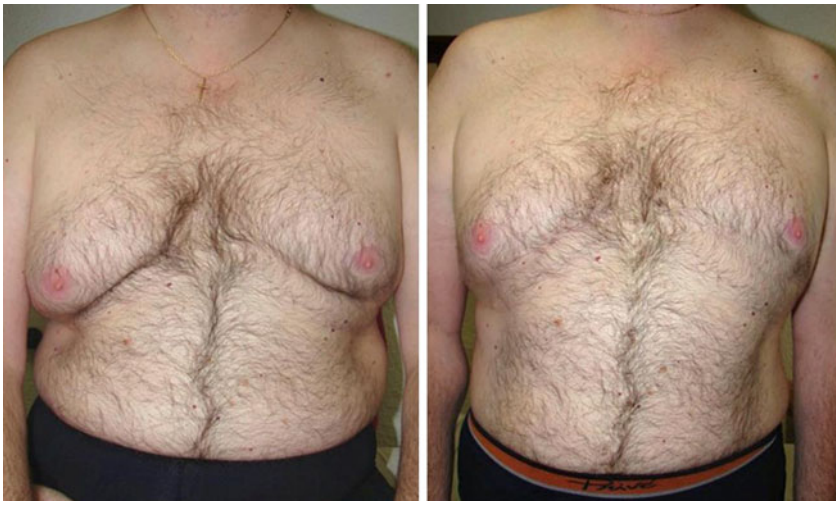

Fig. 2 Patient 14 with grade III gynecomastia (according to the classification of Simon et al. [2]) before LAL (**a**) and 6 months after LAL (**b**)

to evaluate the true outcome of the surgery before 2 months. Skin flaccidity improved progressively until the final assessment at 6 months. Particularly notable was the disappearance of the shadow typically observed below the low breast pole. This detail was clearly satisfactory and appreciated by all patients.

Discussion

Since the first reports of combined treatment for gynecomastia [11], there have been several successful steps in surgical technique, predictability, and esthetic outcome [12]. The technique of combination surgery and suction-assisted surgery was first reported by Teimourian and Perlman [13], and various improvements have been introduced [3, 14]. Moreover, tumescent anesthesia has facilitated the accuracy and safety of this procedure. Since the first work of Apfelberg, a wide range of lasers have been used including the CO_2 laser [9], Nd:YAG laser [15] and diode laser [16]. Compared to the 1,064-nm Nd:YAG laser, which has been proven to be safe and effective for the treatment of gynecomastia [17], the 980-nm diode laser has several advantages: (1) it allows direct coupling between the electric power and light, (2) the energy conversion is excellent compared to other types of laser (about 40%), and (3) these lasers are inexpensive and compact. In this clinical prospective study in 28 patients with gynecomastia, the described technique appeared to be safe and reproducible. The postoperative period in all patients was incident-free. After 6 months, 18 patients (64.3%) scored the result as "very good", 6 as "good" (21.4%), 3 as "fair" (10.7%) and 1 as "poor" (3.6%). Physicians scored the photographs as "very good" in 22 patients (78.6%), "good" in 5 (17.9%), and "fair" in 1 (3.6%).

Despite the lack of a control group, and the small number of procedures, our results appear reliable when compared with the larger series treated with excision, and suction-assisted, ultrasound-assisted and power-assisted liposuction described in the literature. Courtiss [18] reviewed 159 patients who underwent surgical management for gynecomastia, of whom 101 (192 breasts) were treated with excisional techniques. He reported a high complication rate with excisional techniques, including over-resection (18.7%), unattractive scarring (18.7%), hematoma (16.1%), seroma (9.4%), and under-resection (21.9%). A series of 99 patients (197 breasts) treated with power-assisted liposuction was reported by Lista and Ahmad [19]. In three patients, there was a residual solid mass of fibroglandular breast tissue deep to the areola/nipple complex, which needed a complementary excisional technique. Complications (seroma) occurred in two breasts (1%). Rohrich et al. [3] reviewed 61 patients treated with liposuction

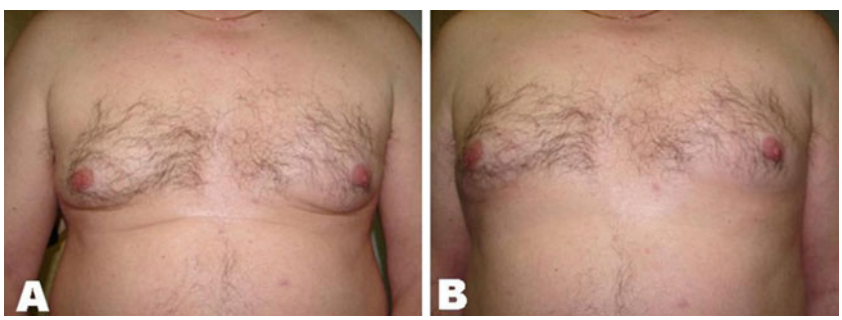

Fig. 3 Patient 16 with grade IIb gynecomastia (according to the classification of Simon et al. [2]) before LAL (**a**) and 6 months after LAL (**b**)

(suction-assisted and power-assisted). No additional treatment was required in 86.9% of patients (53 of 61) treated with either technique. Eight patients (13.1%) required staged excision of remaining breast tissue.

Our overall success rate is easily explained by several factors. First, LAL improves the esthetic outcome because of direct lipolysis and skin contraction. After tumescent anesthesia, adipocytes grow in size, increasing the likelihood of absorption at the 980-nm laser wavelength. Membrane rupture and lipolysis occur as a result of a thermal effect induced by energy absorption. Lipolysis is achieved via thermal damage and fat liquefaction, but no vaporization occurs [20, 21]. Second, lipolysis occurs at a lower temperature than vaporization, which makes the procedure safe and repeatable, and the laser energy accumulated by the breast gives a reference point and contributes to the standardization of the surgical intervention. Third, the high laser energy delivered in continuous mode, besides rupturing the adipocytes, coagulates collagen fibers together with small vessels [20, 21]. As a consequence, surgical injury and bleeding are drastically reduced without changing the hemodynamics [22–24]. Fourth, the process of tissue retraction and skin tightening is rather slow and should not be assessed until 2 months after surgery. Skin tightening continues after this time until 6 months after surgery. It has been reported that it takes about 6 to 8 weeks to develop new collagen fibers following conventional use of lasers for skin rejuvenation and tightening. Fibers are then clearly seen to run parallel below the epidermal/dermal junction and to be responsible for tissue reshaping and to solve flaccidity [25, 26]. Results show that drainage is not required, but that a compression dressing is, according to our observations, mandatory. Finally, recovery time is short and patients can quickly resume normal activities, making the procedure rewarding for both surgeon and patient [27]. The 600-μm optical fiber and 1-mm diameter cannula make this surgery minimally invasive compared with traditional liposuction techniques.

According to our observations, LAL is the first choice for gynecomastia treatment. This combined technique should be considered both when the problem is to remove fibrotic fat in layers of the breast gland and subcutaneous tissue and/or when there is skin flaccidity, or whenever redundant skin is expected to appear after removal of fat. If gynecomastia is voluminous and hard on palpation, reducing breast projection with conventional liposuction can be difficulty. In these cases, subcutaneous mastectomy was, until now, the most effective treatment [28]. Using the 980-nm Toledo cannula, or a cartilage shaver, the gland dome (cup) and the fibrous tissue are effectively eliminated, reducing breast projection and avoiding a pubertal feminine shaped pectoral region. In our series of patients suffering from asymmetry, with well-defined unilateral gynecomastia, the asymmetry was not related to tumor etiology. When cancer is suspected, the gynecomastia would have been addressed according to Leclère et al. [29]. LAL is easy to perform and is reproducible; however, the following precautions should be taken during the procedure:

- Beneath the areola/nipple, tunneling and laser suction should be performed with care to avoid the risk of necrosis [8] and sinking of the breast centre with corollar nipple inversion.
- At the inferior pole, lipolysis should go beyond the inframammary line by approximately 3 cm, especially in the lower external quadrant to prevent shadow production by any skin fold that would give the breast an apparently excessive projection.
- The thermal effect reaches the superficial skin layer, but the cooling device prevents the skin from burning; external controls of temperature during laser irradiation were similar to those reported for nonablative laser treatments [30, 31]. Moreover, to improve the safety of the study, the skin temperature was constantly monitored externally with an infrared thermometer.

Conclusion

LAL for gynecomastia is safe, and produces significant effects on fatty tissue with a reduction in volume of the breast, together with visible skin contraction. Provided an appropriate amount of energy is delivered by an experienced operator, the results are significant and consistent.

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Conflicts of interest None.

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