Laser-Assisted Liposuction Using the Novel 1,444-nm Nd:YAG Laser for the Treatment of Gynecomastia: A Pilot Study

Kwang Ho Yoo, Jung Min Bae, Chae Young Won, Yu Seok Chung, Boncheol Goo, Yong Kwan Rho, Gyong Moon Kim, Jongwon Lee, Byeong Heon Ahn, Beom Joon Kim

Department of Dermatology, College of Medicine, Catholic Kwandong University, International St. Mary’s Hospital, Incheon, Department of Dermatology, Armed Forces Ildong Hospital, Pocheon, Department of Dermatology, St. Vincent’s Hospital, College of Medicine, Catholic University of Korea, Suwon, Clinique L Dermatology, Goyang, Dr. Rho Clinique and Department of Dermatology, Chung-Ang University Hospital, College of Medicine, Chung-Ang University, Seoul, South Korea

Abstract
Background: Laser-assisted liposuction (LAL) is currently widely used to reduce localized fat. A novel Nd:YAG laser that uses a wavelength of 1,444 nm, which is better absorbed by fat, has recently been introduced. In this study, we investigated the efficacy of 1,444-nm Nd:YAG LAL for the treatment of gynecomastia. Patients and Methods: Thirteen Korean male patients (20–28 years, mean age 23 years) diagnosed with gynecomastia were enrolled in this study. All patients were treated by LAL with 1,444-nm Nd:YAG laser (100 μs pulse width, 40 Hz frequency, 300 mJ pulse energy and 12 W power with continuous emission) after tumescent anesthetic infiltration and were then evaluated. Outcome was assessed using the following 4 methods: (1) clinical assessment with photographs obtained before and 12 weeks after LAL treatment, (2) comparison of pre- and postoperative patient chest circumferences, (3) computed tomography (CT) scans to evaluate changes in breast thickness and (4) a patient satisfaction survey at the end of the study. Results: After 12 weeks, most patients (84.5%) showed an improvement greater than 50%. Mean chest circumference was significantly reduced from 109.6 ± 8.2 to 101.2 ± 4.4 cm 12 weeks after LAL (p < 0.001). CT scans showed a significant reduction in mean breast thickness from 22.7 ± 3.2 to 15.6 ± 2.4 mm (p = 0.016). Side effects (pain, edema, numbness and ecchymosis) were minimal and disappeared shortly after the first manifestation. Conclusion: Gynecomastia can be safely treated with 1,444-nm Nd:YAG LAL to reduce fatty tissue and total breast volume.

Key Words
Gynecomastia · Laser-assisted liposuction · 1,444-nm Nd:YAG laser

Kwang Ho Yoo and Jung Min Bae contributed equally to this work.
Introduction

Gynecomastia, which refers to breast hypertrophy in men, is usually caused by a hormonal imbalance and is often seen during puberty and in the elderly. The incidence varies among different age groups. It is so common in adolescents, with an incidence of 64.6% reported in 14-year-olds, that it may be considered normal in this age group. Most cases of gynecomastia are idiopathic; however, pathological etiologies need to be ruled out, and these include congenital and endocrine disorders, tumors and drugs [1].

In the majority of cases, gynecomastia does not require treatment. Only a minority of patients with gynecomastia request treatment due to the psychosocial burden or the pain that it causes. If gynecomastia persists for over a year, medical treatment is unlikely to achieve regression, and surgery is required if the patient wants a correction [2]. The traditional surgical treatment for gynecomastia is a sharp excision of the mammary gland through a semicircular incision on the edge of the areola. The cosmetic outcome of such surgery is often less than ideal, however, because of complications such as scarring, ‘doughnut’ deformities, nipple necrosis, nipple inversion or loss of sensation in the nipple, which have been reported to occur in more than 50% of patients who undergo such procedures [2]. Various surgical methods and techniques have been introduced for an effective treatment of gynecomastia with a low complication rate. The tumescent technique, ultrasonic-assisted liposuction, and endoscopy-assisted subcutaneous mastectomy are examples of such treatments [3]. Despite the wide availability of treatment options, surgical modalities such as tumescent liposuction and laser-assisted liposuction (LAL) are predominantly used.

Tumescent liposuction is an effective treatment to reduce fatty tissue in gynecomastia. However, the skin excess determines the success of the surgery, and the esthetic acceptability of the result in terms of a natural shape and conforming to the pectoral muscle region is also important. LAL, which was first introduced in the early 1990s, has the advantages of (1) excellent patient tolerance, (2) quick recovery time and (3) the additional benefit of dermal tightening [4]. Numerous studies have proven the usefulness of LAL, which has been reported to provide the benefits of both removal of subcutaneous fat as well as tightening of the skin to reduce skin laxity, which has contributed to its popularity [5]. These results are achieved via two primary mechanisms: liquefaction of the adipose tissue and collagen remodeling. The laser delivers energy in the form of heat to the tissue via an optical fiber within a cannula. This heat is absorbed by adipocytes, resulting in damage to the cell membranes. The cell membranes rupture and the liquefied fat can then be removed via simple manual manipulation. The laser energy also serves to denature adipose and dermal collagen, resulting in its remodeling and contraction. This becomes clinically evident as skin tightening [6].

The 1,064-nm Nd:YAG laser is the primary wavelength and laser type used for lipolytic purposes. However, some authors have reported that fat absorbs other wavelengths better than the wavelength of 1,064 nm [7]. For example, a laser within the range of 1,400 nm has a fat absorption rate 10-fold that of a laser with a wavelength of 1,064 nm. A novel Nd:YAG device that emits energy at a wavelength of 1,444 nm has recently been developed; this wavelength is more highly absorbed by adipose tissue and water than other wavelengths currently available [8]. Only a few studies have investigated whether the 1,444-nm Nd:YAG laser enables localized lipolysis of discrete structures within the body and facial regions [9, 10]. To the best of our knowledge, this article is one of the first to report the use of 1,444-nm Nd:YAG LAL for gynecomastia.

Patients and Methods

Patients

Between November 2010 and February 2012, 13 Korean male patients (20–28 years, mean age 23 years) diagnosed with gynecomastia were enrolled in this study. Informed consent was obtained using protocols approved by the Institutional Review Board of St. Vincent’s Hospital of the Catholic University. Patients were asked not to control their diet and exercise during the study period. The increase in breast tissue was asymptomatic and bilateral. Without exception, all patients expressed psychological distress as a result of their gynecomastia. After ruling out gynecomastia of pharmacological origin, levels of estradiol, testosterone, luteinizing hormone/follicle-stimulating hormone and human chorionic gonadotropin were within normal ranges. Furthermore, hepatic, renal and thyroid laboratory tests showed no abnormalities in any patients. Gynecomastia was assessed using the classification of Anderson et al. [7]. The mean gynecomastia duration was 5.38 years (range 3–10 years). The mean body mass index was 25.92. A summary of these data is provided in table 1.

Therapeutic Procedures

Patients were prepped and draped after surgical marking. A 6-mm subareolar incision was made, and a 4-mm diameter, 9-cm-long blunt 16-gauge cannula was introduced to carry out tunneling, dragging and fanning maneuvers. An anesthetic solution composed of 500 ml lactated Ringer’s solution, 50 ml 2% lidocaine, 5 ml sodium bicarbonate and 1 ml epinephrine 1:1000 (1 mg/ml) was administered via local infiltration. The amount of anesthetic

1,444-nm Nd:YAG LAL for Gynecomastia in Korean Males

DOI 10.1159/000430494

Dermatology 2015;231:224–230
was never less than 500 ml/breast. The 1,444-nm Nd:YAG laser system (Accusculpt®, Lutronic Corporation, Goyang, South Korea) was used for lipolysis in this study. The parameters used were as follows: 600 μm optic fiber diameter, 100 μs pulse width, 40 Hz frequency, 300 mJ pulse energy and 12 W power with continuous emission. The total exposure time depended on the gynecomastia volume. The total energy delivered per patient bilaterally ranged from 800 to 1,500 J. The position of the cannula was easy to check due to highlighting via transillumination by a red guide beam. The tip of the fiber was placed on the hypodermis or subcutaneous fatty layer, and the cannula was moved in a forward and backward fanning motion. When acting on a superficial plane, hand movements were careful and quicker in the areola-nipple complex area to avoid damage to the vascular pedicle. The clinical end point was softness felt by palpation, which served as an indicator of liquefaction of adipocytes. After the procedure, aspiration was performed at 1 bar negative pressure with the 4-mm cannula previously used for tunneling. After aspiration, additional laser treatment of the hypodermis (40 Hz frequency, 150 mJ pulse energy, 6 W power and total energy of 1,000 J) was conducted for the purpose of skin tightening. Manual examination was then performed to detect possible irregularities in breast shape. Incisions were sutured with a single 4-0 nylon stitch. A small bandage with a piece of gauze was then applied to the incision site. Patients were asked to keep commercial elastic bandages (Daehan Medical Supplies Corp., Seoul, South Korea) wrapped around both of their breasts for 7 days for compression purposes.

### Evaluation of Efficacy

At baseline and at 12 weeks, gross breast pictures were taken by a medical photographer. Subjects were photographed in the same position, with the same lighting and camera setup, and by the same photographer, using a digital camera (Nikon D80®, Nikon, Tokyo, Japan). Two dermatologists assessed the treatment responses by comparing pictures of breasts before and after laser treatment using a quartile grading scale (grade 1 = <25%; grade 2 = 25–50%; grade 3 = 51–75%; grade 4 = >75% improvement). Chest circumference was measured before surgery and 12 weeks after surgery. It was always measured at a standard height using a tape measure at the level of the nipples with the patient standing and in expiration. Computed tomography (CT) scans were taken before and 12 weeks after treatment to evaluate the thicknesses of the subjects’ breast fat layers. Breast thicknesses at the subareolar level were measured from the CT images by a blinded radiologist. At the end of the study, the patients documented their degree of subject satisfaction on a scale ranging from 1 (lowest) to 10 (highest). Clinical symptoms and adverse events were also reported.

### Statistical Analysis

Data analyses were performed using SPSS 12.0 (SPSS Inc., Chicago, Ill., USA). The paired t test was used to compare changes in chest circumference and breast thickness before and after LAL. A p value of less than 0.05 was considered significant.

### Results

All 13 patients were subjected to LAL without follow-up loss. No statistically significant changes in patients’ weights and waist sizes were observed after 12 weeks (table 1). Twelve weeks after treatment, independent comparison of the baseline and posttreatment photographs by the two dermatologists showed significant improvement in the grading scale (grade 1 = <25%; grade 2 = 25–50%; grade 3 = 51–75%; grade 4 = >75% improvement). Chest circumference was measured before surgery and 12 weeks after surgery. It was always measured at a standard height using a tape measure at the level of the nipples with the patient standing and in expiration. Computed tomography (CT) scans were taken before and 12 weeks after treatment to evaluate the thicknesses of the subjects’ breast fat layers. Breast thicknesses at the subareolar level were measured from the CT images by a blinded radiologist. At the end of the study, the patients documented their degree of subject satisfaction on a scale ranging from 1 (lowest) to 10 (highest). Clinical symptoms and adverse events were also reported.

### Table 1. Demographics of gynecomastia patients

<table>
<thead>
<tr>
<th>Case</th>
<th>Age, years</th>
<th>Classification</th>
<th>Duration, years</th>
<th>BMI</th>
<th>Weight (pre/post), kg</th>
<th>Waist (pre/post), cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>IIb</td>
<td>4</td>
<td>26</td>
<td>78/79</td>
<td>86/87</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
<td>IIa</td>
<td>6</td>
<td>22</td>
<td>68/68</td>
<td>76/76</td>
</tr>
<tr>
<td>3</td>
<td>22</td>
<td>IIb</td>
<td>5</td>
<td>25</td>
<td>73/72</td>
<td>84/83</td>
</tr>
<tr>
<td>4</td>
<td>28</td>
<td>IIb</td>
<td>10</td>
<td>28</td>
<td>88/86</td>
<td>96/95</td>
</tr>
<tr>
<td>5</td>
<td>24</td>
<td>IIb</td>
<td>7</td>
<td>27</td>
<td>87/87</td>
<td>93/92</td>
</tr>
<tr>
<td>6</td>
<td>23</td>
<td>IIa</td>
<td>7</td>
<td>26</td>
<td>87/85</td>
<td>89/87</td>
</tr>
<tr>
<td>7</td>
<td>21</td>
<td>IIa</td>
<td>3</td>
<td>24</td>
<td>70/70</td>
<td>81/81</td>
</tr>
<tr>
<td>8</td>
<td>20</td>
<td>IIb</td>
<td>4</td>
<td>27</td>
<td>89/89</td>
<td>91/92</td>
</tr>
<tr>
<td>9</td>
<td>22</td>
<td>IIb</td>
<td>6</td>
<td>29</td>
<td>95/96</td>
<td>98/99</td>
</tr>
<tr>
<td>10</td>
<td>25</td>
<td>IIb</td>
<td>4</td>
<td>26</td>
<td>77/75</td>
<td>83/83</td>
</tr>
<tr>
<td>11</td>
<td>24</td>
<td>IIb</td>
<td>7</td>
<td>28</td>
<td>87/88</td>
<td>93/94</td>
</tr>
<tr>
<td>12</td>
<td>24</td>
<td>IIa</td>
<td>4</td>
<td>25</td>
<td>73/72</td>
<td>84/83</td>
</tr>
<tr>
<td>13</td>
<td>23</td>
<td>IIa</td>
<td>3</td>
<td>24</td>
<td>72/70</td>
<td>80/79</td>
</tr>
</tbody>
</table>

Gynecomastia was assessed using the classification of Trelles et al. [4]. Grade 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. BMI = Body mass index.
in all patients. Eight patients (61.5%) showed grade 4 improvement; 3 (23.0%) showed grade 3 improvement, and 2 (15.3%) showed grade 2 improvement (fig. 1, 2). Patients’ breast sizes decreased 12 weeks after 1,444-nm LAL.

The chest circumferences and breast thicknesses of all patients before and 12 weeks after treatment were compared using CT images. The mean chest circumference diminished significantly after LAL. The mean circumference changed from 109.6 ± 8.2 cm before LAL to 101.2 ± 4.4 cm at 12 weeks (fig. 3, p < 0.001). In the CT images, the thicknesses of the breasts were significantly reduced as well (fig. 4). The mean breast thickness changed from 22.7 ± 3.2 mm before LAL to 15.6 ± 2.4 mm at 12 weeks (fig. 5, p = 0.016).

All patients were satisfied with their treatment results; the mean patient satisfaction score was 8.4 (on a scale of 0–10). Sixty-one percent of patients (8 patients) reported satisfaction ratings of grades 8–10, and 5 patients reported satisfaction ratings of grades 6 and 7.

Side effects during and after treatment were mostly mild pain and swelling, numbness and bruising. How-

**Fig. 2.** Patient 4, a 22-year-old man. a Before treatment. b Twelve-week follow-up. Grading scale score = 3.

**Fig. 3.** Changes in mean chest circumference at baseline and 12 weeks. The mean circumference reduction between baseline and 12 weeks was statistically significant (* p = 0.000).
ever, all events were mild in nature throughout the first few days and resolved within 1–2 weeks following the procedure. There were no incidences of burns, seromas, hematomas, infections or nerve damage.

Discussion

Gynecomastia results from an imbalance between estrogens and androgens or from an increase in the sensitivity of breast tissue to estrogens. In recent years, following the development of antiandrogens for prostate cancer and alopecia, iatrogenic gynecomastia has become increasingly frequent [1]. In the majority of cases, gynecomastia does not require treatment. However, in some cases, gynecomastia does not regress substantially despite total body weight changes, probably because of the presence of fibrosis; in these cases, surgical treatment is required [11, 12].

Since the first reports of combined treatment for gynecomastia [13], progress has been made in surgical techniques, predictability and esthetic outcomes [14]. Use of combination surgery together with suction-assisted surgery was first reported by Teimourian and Perlman [15], and various improvements have since been introduced [16]. Tumescent liposuction was first introduced in the USA in the early 1980s, and is one of the most commonly performed cosmetic fat-contouring procedures. Furthermore, the tumescent technique was refined in the mid-1980s. Liposuction is one of the most widely used and effective methods for the surgical treatment of gynecomastia since it was introduced [2]. However, because patients prefer to be treated by a less invasive technique with minimal discomfort afterwards, new minimally invasive therapies have been introduced [3, 6].

![Fig. 4. CT images of patient 4. a Before treatment. b Twelve-week follow-up. The right side thickness was reduced from 32.33 to 19.97 mm and that of the left side from 27.38 to 17.68 mm.](image)

![Fig. 5. Changes in mean breast thicknesses between baseline and at 12 weeks in the CT images (* p < 0.05).](image)
LAL has been widely used since its introduction due to the small caliber of the fiberoptic tip, which makes it useful in delicate areas such as the face, forearms, upper abdomen and knees. Furthermore, the ability of LAL to induce coagulation of small vessels in the fat tissues is associated with less bleeding and an improved recovery time [17]. Importantly, it improves esthetic outcomes because of direct lipolysis and enhances collagen synthesis. However, sufficiently blinded comparison studies between tumescent liposuction and LAL have concluded that the skin tightening effect of LAL is not significantly better than that of tumescent liposuction.

Heating of the deep dermis and conjunctive septa of subcutaneous tissues induces collagen denaturation and heat shock protein production, followed by vascular proliferation and collagen neosynthesis [17]. Some authors have reported that use of Nd:YAG lasers resulted in significantly greater expression of type I and III procollagen and tissue inhibitors of metalloproteinases, but lower expression of matrix metalloproteinases, effectively accelerating collagen synthesis and inhibiting collagen degradation [6]. It has been reported that it takes about 6–8 weeks to develop new collagen fibers following conventional use of lasers for skin rejuvenation and tightening. Fibers are then clearly seen to run parallel to the epidermal junction and to be responsible for tissue reshaping and solving flaccidity [4]. Consequently, skin tightening is induced. To investigate the skin tightening effect of the 1,444-nm Nd:YAG laser, long-term and quantitative evaluations of collagen remodeling are needed. We did not evaluate the skin tightening effect of the 1,444-nm Nd:YAG laser as this was beyond the scope of our study.

A major problem with using LAL is that it is labor intensive and requires more time than other methods. Understandably, practitioners want improved and refined laser instrumentation that is more effective than traditional methods [8]. Multiple LAL devices are currently available. There are two main systems – near-infrared diode and Nd:YAG – with the primary difference being that the diode devices deliver shorter wavelengths in the electromagnetic spectrum than the Nd:YAG devices. The wavelengths delivered by these devices range from 920 to 1,444 nm [18]. There has been much discussion regarding the optimum wavelength for liquefying adipose tissue and reducing skin laxity. Recently, a novel device was developed that uses the 1,444-nm wavelength, which could be key to resolving these arguments.

The 1,444-nm wavelength has been shown to be absorbed much better by both adipose tissue and water than shorter wavelengths, and may therefore have greater adipolytic activity, and the thermal reaction may be more confined than other wavelengths. Theoretically, use of the 1,444-nm Nd:YAG laser should result in more effective LAL, because fat has a 10-fold greater affinity for this wavelength than the 1,064-nm wavelength [19]. In addition, fat contains 14% water and collagen contains approximately 60% water [20]. The greater affinity of fat and water for the 1,444-nm wavelength focuses energy and heat in the adipose tissue. Consequently, the 1,444-nm Nd:YAG accomplishes more work with the same amount of energy output than other wavelength lasers. In a recent study, 1,444 nm was shown to be superior to 1,064 nm in terms of lipolysis potential based on an in vivo minipig and ex vivo human fat model; the 1,444-nm laser required approximately 5.2-fold less energy than that needed by the 1,064-nm Nd:YAG laser to produce the same degree of lipolysis [8]. In a further comparative ex vivo study, the 1,444-nm laser showed significantly better thermal confinement and higher lipolytic potential than the 1,064- and 1,320-nm wavelengths of the Nd:YAG laser [21]. It was therefore proposed that the greater the wavelength selectivity of the intended tissue, the greater the energy absorption and the more localized heating of that tissue [22].

Greater thermal confinement and limited unintended collateral thermal injury are potential clinical benefits of LAL using a 1,444-nm laser [23]. This might afford safer contouring with less risk of adjacent tissue damage as well. We also found that patient tolerance was good. The only side effects were pain, swelling, numbness and ecchymosis, all of which were temporary and disappeared soon after they had first manifested themselves. The 600-μm optical fiber and 4-mm diameter cannula used in this study also contributed to the minimally invasive nature of the LAL. Furthermore, energy could be relatively greater at the tip of the laser fiber, which is an extremely important feature that enables safe use of this technology by preventing hematological discomfort.

As public demand for less invasive and highly effective procedures grows, doctors must continue to explore and develop new treatment options and combinations. We demonstrated that 1,444-nm Nd:YAG LAL reduces the breast size of gynecomastia patients without serious complications. However, because of the small size of the treatment group and short-term follow-up, further studies should be conducted to confirm these findings. In addition, histological studies are needed to evaluate changes in collagen and elastin fibers and determine whether clinical findings correlate with skin tightening.

1,444-nm Nd:YAG LAL for Gynecomastia in Korean Males

Dermatology 2015;231:224–230
DOI: 10.1159/000430494

Downloaded by: 54.191.40.80 - 4/19/2017 1:29:47 AM
Conclusions

Despite the lack of a control group, the 1,444-nm Nd:YAG LAL procedure performed in this study resulted in significant clinical improvement in gynecomastia in study participants. When performed by an experienced doctor, this modality might be one of the best options with significant and consistent results. However, to confirm the superiority of the effects of the 1,444-nm Nd:YAG laser, comparative studies with other wavelength lasers (1,064 and 1,320 nm) and conventional liposuction are warranted.

References


Acknowledgments

This work was supported by the Infrastructure Program for New-Growth Industries (10044186, Development of Smart Beauty Devices Technology and Establishment of Commercialization Support Center) funded by the Ministry of Trade, Industry and Energy (South Korea).

Disclosure Statement

We have no conflicts of interest.