

# Low Level Laser Versus ND; YAG Laser on Abdominal Adiposity After Gastric Bypass in Females

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## ABSTRACT

**Introduction:** Compared to other anthropometric measures, the correlation between intrahepatic fat and visceral adipose tissue (VAT) is stronger. There have been reports that a brief session of low-level laser therapy can "liquefy" or release stored fat in adipocytes through the opening of certain, as-yet-unidentified pores associated with the cell membrane. With its low dispersion, the 1064 nm laser energy can heat the hypodermis with precision since it can penetrate deeper into the tissue. **Objective:** This research aimed to examine effectiveness of the Low-level laser versus ND; YAG laser on abdominal adiposity after gastric bypass in females. **Material and methods:** Fifty female patients with abdominal adiposity after gastric bypass, were distributed into two groups. Group (A) was given the low-level laser therapy. Group (B) was given ND; YAG laser, the treatment lasted for a total of three months and consisted of thirty minutes on alternate days. abdominal circumference, Ultrasonographic Fatty Pad Depth and body composition were assessed before and after treatment. **Results:** Both groups A and B showed significant enhancement in abdominal circumference, Ultrasonographic Fatty Pad Depth and body composition ( $p < 0.001$ ). In comparison to Group B, Group A showed significantly better results across all measurement ( $p < 0.001$ ). **Conclusion:** The utilization of both low-level laser therapy as well as ND; YAG laser demonstrated significant effects in treating abdominal obesity in females' post-gastric bypass.

**Keywords:** words (Low level laser therapy, ND; YAG laser, Abdominal adiposity, Abdominal Ultrasonography).

**How to cite this article:** Azmy MA, Mowafy ZME, El-Gammal ER, Ali KM. Low Level Laser Versus ND:YAG Laser on Abdominal Adiposity After Gastric Bypass in Females. *Int J Drug Deliv Technol.* 2026;16(19s): 661-666. DOI: 10.25258/ijddt.16.19s.76

**Source of support:** Nil.

**Conflict of interest:** None

## INTRODUCTION

Obesity has numerous root causes and ranks high among metabolic disorders affecting humans. An excessive amount of fat that develops when calorie consumption exceeds energy expenditure. The prevalence of obesity is becoming a major public health concern. Obesity (defined as a body mass index (BMI) of 30 or above) has risen from 13% to 31% in adults over the past 40 years, with similar increases seen in children and adolescents. Developed countries have a disproportionately high obesity rate. The clinical term for the accumulation of fat in the abdominal region that causes a larger waist is "abdominal obesity," which goes by several names. Central obesity is strongly associated with cardiovascular disease [1].

A gastric bypass procedure (GBP) is one of several comparable operations that include rearranging the small intestine so it can connect to both the upper pouch as well as the lower, larger "remnant" pouch after dividing the stomach into two smaller pouches. There are a number of various names for GBP since surgeons have come up with a variety of methods to rejoin the intestine. A significant decrease in the stomach's functional volume and changes in the body's physiological and physical reactions to meals are symptoms of any GBP [2].

The use of low-level laser irradiation in acupuncture is one of the medicinal applications of low-level laser treatment. Research has shown that a combination of a low-calorie diet and laser acupuncture can effectively cure visceral postmenopausal obesity. Recent

clinical observations demonstrated that obese individuals could lose weight and reduce their body mass index (BMI) using laser acupuncture alone; however, this study did not include a placebo control. Additionally, there was a lack of clarity regarding how laser acupuncture affected body composition, and additional research on the effectiveness of laser acupuncture in treating obesity is required [3].

With its low dispersion, the 1064 nm laser energy from neodymium-doped yttrium aluminum garnet can heat the hypodermis with precision since it can penetrate deeper into the tissue. In its original form, diode lasers were efficient for treating vascular lesions and permanently reducing hair growth at wavelengths of 900 to 1000 nm. Their inability to precisely and efficiently target the chromophores in the focal fat region was their Achilles' heel, though. There is evidence that the 1064-nm wavelength can reach deeper layers of tissue than the 980-nm wavelength [4].

Recently, the internal use of the neodymium: Yttriumaluminum-garnet (Nd: YAG) laser for laser lipolysis was approved by the FDA in the US and in some European and South American countries. Many studies have demonstrated the useful aspects of the subdermal laser action not only in the fat but also in surrounding tissues (dermis, vessels, sweat glands and sebaceous glands). Among the effects related directly to the use of 1,064 nm Nd: YAG laser are fat cell disruption and stimulation of new collagen formation. The consequent skin and tissue tightening represents the most useful aspects of this

modality for skin laxity and localized fat of the arms [5]. Subsequently, the purpose of this study is to compare the effectiveness of low-level laser therapy (LLLT) with the 1064 Nd:YAG laser in the treating of post-gastric-bypass abdominal obesity.

### **MATERIALS AND METHODS:**

This study was done on 50 female patients who applied gastric surgeries of age between 25 – 45 years. Group (A): this group included 25 female patients who applied gastric bypass surgeries was given LLLT 3 times per week, low caloric diet was applied for 12 weeks after 6 weeks of the operation. Group (B): this group included 25 female patients who applied gastric bypass surgeries was given 1064 Nd:YAG laser 3 times per week, low caloric diet was applied for 12 weeks after 6 weeks of the operation.

The criteria for patient's selection were classified into two various criteria:

**Inclusive criteria:** The patients were selected under the following criteria: fifty female patients who applied gastric surgeries of age between 25 – 45 years, the participants in the study all had generally healthy skin and were free of serious diseases. They were all within a stable medical and clinical state, and each of them had a BMI greater than 40 kg/m<sup>2</sup>.

**Exclusive criteria:** Patients with the following conditions were excluded from this study: fluctuating blood pressure, congestive heart failure, osteoporosis, anemia, mental disturbance, phototherapy sensitivity, pregnancy, anticoagulant therapy, history of cancer, and acute dermatitis at the treated location. Before beginning treatment, we took baseline measurements; after three months of treatment, we took final measurements to complete the record.

### **Bottom of Form Randomization**

Each participant was informed about the nature, goals, and advantages of the study, and they were also given the option to stop participating at any time. We collected demographic data once participants signed the consent forms. The fifty subjects were divided evenly between Groups A and B by an independent researcher who used computer-generated random cards contained in opaque, sealed envelopes. To guarantee the hidden allocation, each envelope was sealed and numbered in a specific order; participants were not informed of their group assignment [6].

### **Outcomes measures**

Pre- and post-intervention measurements were collected for the 12-week intervention.

**A- Plastic tape measurement:** It is used to measure abdominal circumference measurement (ACM) in cm. Placing a plastic tape at the level of the umbilicus, the patient was asked to stand while their abdominal circumferences were measured in centimeters.

**(b) InBody 270 Body Composition Analyzer:** used for measurement of the body fat mass in Kg (BFM). The InBody 270 uses bioelectrical impedance to measure body composition, focusing mainly on body fat. It sends an electric current through the water in your body, and the resistance to this current is measured, which helps the machine determine percent body fat (PBF).

**(c) Ultrasonography:** It is used to determine the

Ultrasonographic Fatty Pad Depth (FPD) in cm. various tissues have various acoustic properties, and this is the basis of it. It was common practice to have the patient lie supine during the measurement process. In order to prepare the probe for testing, it was essential to immerse its tip in saltwater and carefully massage it with a bent brush to remove any air bubbles. To avoid obliquity and ensure accurate estimation of the Ultrasonographic Fatty Pad Depth (FPD) in cm, the transducer was positioned perpendicular to the skin during imaging. For better visibility in the near field and to prevent tissue compression, which might affect the measurements used to determine the Ultrasonographic Fatty Pad Depth (FPD) in cm, a thick coating of ultrasonic gel is placed [7].

### **Bottom of Form Intervention**

#### **Low level laser therapy application:**

**Study device.** The device used in this study comprises six independent 17mW, 635nm red laser diodes (Erchonia® Zerona 6-Headed Scanner (EZ6); Erchonia Corporation, McKinney, Texas). The device utilizes internal mechanics, which collects the light emitted from each laser diodes and processes it through a proprietary lens system that redirects the beam with a line refractor. The refracted light is then bent into a circular pattern that is completely random and independent of other individual diodes. Each diode emits a line of light approximately 3mm wide and 9cm long having an energy of approximately 0.0002 joules per cm<sup>2</sup>/minute/treated area at a distance of 3 inches (7.6cm) and approximately 0.0001 joules per cm<sup>2</sup>/min/treated area at a distance of 4 inches (10.2cm). subjects laying on their back on a procedure table, the device was positioned 6 inches (15.2cm) above their lower and upper abdomen, stomach was activated for exactly 30 minutes. Use of a full-body vibration plate machine for around ten minutes immediately following treatment yields beneficial effects. Two sessions of treatment were administered weekly for twelve weeks [8].

#### **1064 Nd: YAG laser application:**

For a total of twelve weeks, patients had laser treatments once every three weeks. The device (Venus Bliss, Toronto, Canada) utilized With a fluence value of 108 J/cm<sup>2</sup> as well as a power flux density of 1.2 W/cm<sup>2</sup>, the S11-L-Runner scanning hand piece was used to apply the 1064 nm Nd:YAG. The scanning surface measured 78 mm × 84 mm. The skin areas of each participant were addressed in nine fields: five on the upper abdomen, two on the right side of the waist, and two on the left side of the waist. For 8 minutes, the surface temperature of the skin was 42 degrees Celsius. The temperature of the skin was measured using a specialized MatrixView thermometer. Neither local anesthetic nor skin cooling were used during the procedure. Immediate results can be achieved by using a full-body vibration plate machine for approximately 10 minutes following treatment [9].

### **STATISTICAL ANALYSIS**

An unpaired t-test was utilized to compare subject characteristics across groups, while the sex distribution was compared using a chi-squared test. The Shapiro-Wilk test was applied to determine if the data were normally distributed. To test the homogeneity of variances across groups, Levene's test was utilized. A mixed MANOVA was utilized to examine the effects of the intervention on knee

flexor and extensor strength, the BBS, as well as the LEFS. Upon obtaining statistically significant results from MANOVA, follow-up univariate ANOVAs with Bonferroni correction were conducted for each outcome measure to reduce the risk of type I error. Statistical tests were conducted at a significance level of  $p < 0.05$ , employing SPSS version 25 for Windows (IBM SPSS, Chicago, IL, USA). No withdrawals occurred in this study, and all participants completed the treatment program [10].

**Data analysis:**

Abdominal circumference measurement (ACM) in cm, InBody 270 body composition analyzer for detection of the Body Fat Mass in Kg (BFM) and Ultrasonographic measurements of Fatty Pad Depth (FPD) in centimeters were recorded pre-treatment as an initial assessment and after a 3-month intervention as a final assessment in both groups. Data were input into a computer for statistical

analysis, where descriptive statistics including mean, standard deviation, minimum, and maximum were determined for each group. The t-test was conducted to assess the mean differences between the two groups pre and post the intervention, as well as within each group. A significance level of 0.05 was employed [11].

**RESULTS**

Table (1) and figure (1) indicate that the mean value of the ACM in cm prior to treatment was  $(120.1400 \pm 5.844)$  in the Low Level Laser group, whereas post-treatment it was  $(120.140 \pm 5.844)$  cm. The findings indicated a statistically significant reduction in the ACM ( $P < 0.0001$ ). In the ND; YAG laser group, the mean value of the ACM prior to treatment was  $(121.100 \pm 5.404)$  cm, whereas post-treatment it was  $(111.650 \pm 5.635)$  cm. The findings indicated a statistically significant reduction in the ACM ( $P < 0.0001$ ).

**Table 1 Shows the statistical analysis of AGE mean difference, t. and probability values and the level of significance in the two groups; between group (A) and group (B).**

AGE statistical analysis		
	Group (A)	Group (B)
Mean of AGE in years	35.6000	35.7200
+ standard deviation	5.9161	6.0658
Standard error	1.1832	1.2132
Mean difference	-0.120000	
t.value	-0.68	
p. value	0.503	
Level of significance	Non significant	

**Table (2): Comparison of the mean values of the Abdominal circumference measurement (ACM) in cm, before and after treatment in the two groups**

	Before treatment		After treatment		Mean difference	T-value	P.value	Level of significance
	Mean	SD	Mean	SD				
Low level laser Group	120.140	5.844	114.330	5.562	5.81000	3.60	0.001	significant increase
Nd:YAG laser Group	121.140	5.404	111.650	5.635	9.49000	6.08	0.0001	Highly significant increase

Table (2) presents the mean value of Body Fat Mass in kilograms (BFM) prior to treatment as  $(56.7000 \pm 12.506)$  in the low-level laser group, compared to  $(50.106 \pm 12.661)$  mg post-treatment. The results indicated a significant reduction ( $P > 0.07$ ). In the ND; YAG laser group, the mean Body Fat Mass (BFM) in kilograms prior to treatment was

$56.8000 \pm 12.699$ , whereas post-treatment it was  $48.5500 \pm 11.330$ , these results revealed a highly significant reduction in of the Body Fat Mass in Kg (BFM) ( $P < 0.0001$ ).

**Table (3): Comparison of the mean values of the Body Fat Mass in Kg (BFM) before and after treatment in the two groups**

	Before treatment		After treatment		Mean difference	T-value	P.value	Level of significance
	Mean	SD	Mean	SD				
Low level laser Group	56.7000	12.506	50.106	12.661	6.59400	1.85	0.07	Significant decrease
Nd:YAG laser Group	56.8000	12.699	48.5500	11.330	8.25000	2.42	0.0019	Highly significant decrease

As shown in table (3), the mean value of the Ultrasonographic Fatty Pad Depth (FPD) in cm before treatment was  $(5.544 \pm 0.705)$  in the low level laser group, while after treatment was  $(4.066 \pm 0.522)$ . These results revealed a highly significant decrease, ( $P > 0.0001$ ), while in the ND; YAG laser group, the mean value of the Ultrasonographic Fatty Pad Depth (FPD) in cm prior to

treatment was  $(5.542 \pm 0.757)$  mg, but post treatment was  $(3.3200 \pm 0.245)$ , these findings showed a highly significant reduction in of the Ultrasonographic Fatty Pad Depth (FPD) in cm ( $P < 0.0001$ ).

**Table (4): Comparison of the Ultrasonographic Fatty Pad Depth (FPD) in cm, before and after treatment in the two groups**

	Before treatment		After treatment		Mean difference	T-value	P.value	Level of significance
	Mean	SD	Mean	SD				
<b>Low level laser Group</b>	<b>5.644</b>	<b>0.705</b>	<b>4.066</b>	<b>0.522</b>	<b>1.57800</b>	<b>8.99</b>	<b>0.0001</b>	<b>Highly significant decrease</b>
<b>Nd:YAG laser Group</b>	<b>5.542</b>	<b>0.757</b>	<b>3.3200</b>	<b>0.245</b>	<b>2.22200</b>	<b>13.96</b>	<b>0.0001</b>	<b>Highly significant decrease</b>

## DISCUSSION

The primary results showed that compared to low-level laser therapy on abdominal adiposity following gastric bypass in women, ND; YAG laser significantly improved abdominal circumference, ultrasound fatty pad depth, and body composition. Both Groups A and B shown notable improvements in belly circumference, Ultrasonographic Fatty Pad Depth, and body composition following therapy ( $p < 0.001$ ). Across all measurements, Group A had significantly superior performance than Group B ( $p < 0.001$ ).

After therapy, the low level laser group had an average Ultrasonographic Fatty Pad Depth (FPD) of  $4.066 \pm 0.522$  cm, down from  $5.544 \pm 0.705$  cm before treatment. The results showed a significant decrease ( $P > 0.0001$ ) in the Ultrasonographic Fatty Pad Depth (FPD) in cm in the ND; YAG laser group compared to the control group ( $3.3200 \pm 0.245$ ). The difference between the two groups was statistically significant ( $P < 0.0001$ ).

A rapidly expanding field of cosmetic operations is non-invasive body reshaping techniques. One important component of these methods is the use of lasers. With its potential to aid in wound healing and its ability to alleviate inflammation, edema, and discomfort, LLLT has a broad range of potential uses. In addition, it can be used to make liposuction more effective and less invasive, but it can also be used on its own to reduce fat [12, 13]. There are many ways in which low-level laser thermotherapy (LLLTT) can remove fat. One possible mechanism by which LLLTT releases intracellular lipids from adipocytes is the creation of temporary micropores [14]. Complement activation [16] and reactive oxygen species generation [15] may potentially play a role in the process. Also, mitochondrial chromophores absorb laser light, which increases cAMP levels. This, in turn, promotes cytoplasmic lipase, which converts triglycerides into glycerol and fatty acids [17]. The local temperature is raised by laser application, which decreases the viability of adipocytes [18].

These findings are in line with those of Da Silveira Campos et al. (2018), who looked at the effects of LLLT (808 nm) on insulin resistance, noninvasive body contouring treatments, and overall body fat. The researchers

found that LLLT improved measures of body mass, BMI, fat mass, lean mass, visceral fat, and waist circumference, with a more pronounced effect on fat mass. Body composition can be improved with exercise trainings that include LLLT [19]. The present study's findings, however, run counter to those of Jankowski et al. (2017), who investigated the impact of LLLT on subcutaneous adipose tissue reduction and discovered no statistically significant reduction of abdominal subcutaneous adipose tissue following the treatment program [20]. A total of sixty women, ranging in age from forty to fifty, were examined by Elsherbeni et al. (2018) for their obesity and abdominal obesity. Thirty women made up each of the two groups: the study and the control. The average body mass index (BMI) for the research group was  $32.75 \pm 1.29$  kg/m<sup>2</sup>, whereas for the control group it was  $33.19 \pm 1.48$  kg/m<sup>2</sup>. A balanced, low-calorie diet and three sessions of vigorous walking per week were given to both groups. The research group also had LLLT, which consisted of 20 minutes of therapy three times weekly for a total of four weeks. Prior to and during the completion of the trial, ultrasonography was used to determine the ratio of abdominal visceral to subcutaneous tissue. Following the trial's conclusion, the averages of both groups' AVF and ASF, as well as the study group's abdominal V/S fat ratio, showed a considerable improvement. Obese women can safely and effectively reduce their abdomen fat with low-level laser treatment [21]. Additional research with 67 overweight individuals randomly assigned to six LLLT treatments (real LLLT or sham LLLT) confirms this connection [22]. off the beginning to the completion of therapy, 63% of the active participants in this placebo-controlled research lost at least 3.0 inches off their waist, hips, and both thighs, compared to 6% in the control group. A 2.4-inch decrease in waist circumference (from baseline to end of therapy) and a 1.5-inch reduction (from end of study to baseline) were noted in our study. Historical research has provided credence to the claims that LLLT can reduce some body measurements (such as the waist, hips, and thighs) and even cause weight loss [23].

The beneficial impact Laser lipolysis may be more successful at the 1064 nm wavelength because its reduced

absorption coefficient allowed it to reach deeper fat tissues. Heat, which enhances the local rate of fat cell disintegration, is the primary mechanism of action of the 1060nm laser for lipolysis. Fatty acid transporters facilitate the release of free fatty acids and glycerol from cells when triglycerides undergo thermal breakdown. They are then able to enter the bloodstream and attach to albumin, which facilitates their transport and subsequent cellular metabolism [24,25]. The amount of energy provided to the target has been used to assess lasers of different wavelengths [26]. Although it did not cause skin tightening, a wavelength of 924 nm demonstrated the largest difference in absorption by fat relative to skin [27]. On the other hand, a 1064 nm laser could target subcutaneous fat while preserving skin tissue, had a greater absorption rate by fat, and penetrated tissues larger than 900 nm. When fat cells in the subcutaneous layer are heated to temperatures between 42 and 47 degrees Celsius by the 1060 nm laser, they undergo apoptosis and the fat is subsequently reduced [28,29]. Similarly, the present study's findings were consistent with those of Lee et al., 2024, who used mini pigs in a preclinical trial to assess the efficacy and safety of a 1060 nm laser for the breakdown of abdominal fat. At 60 days, 1.1 W/cm<sup>2</sup> laser irradiation decreased adipose tissue volume by 40%, and at 90 days, the reduction was 30%, according to ultrasound imaging and histological examination, respectively. The 1060 nm laser lipolysis procedure was determined to be safe by histological examinations and blood testing. Hence, it is safe to use non-invasive laser therapy to decrease belly fat [30]. The 2017 article by Decorato et al. detailed the results of a pilot clinical research that investigated the use of a 1060 nm laser system for abdomen lipolysis. As early as 5 to 7 days after treatment, biopsies taken from the treated abdomen tissue revealed inflammatory alterations when stained with hematoxylin and eosin. After 14 days, adipocytes began to exhibit damage indicators. Even one month after therapy, macrophages encircled any remaining adipocytes; by two or three months after treatment, foamy macrophages and cystic areas were plainly apparent. The frequency of foamy macrophages had reduced and fibrosis had become noticeable by the sixth month. Importantly, the authors found no evidence of treatment-related alterations in blood lipids or liver chemistries. Furthermore, compared to results obtained after cryolipolysis, ultrasonography and magnetic resonance imaging showed a decrease in abdominal fat [31].

This study's findings corroborate those of Kislevitz et al., 2021, which found that a single treatment with a 1060-nm diode laser successfully reduced abdominal fat tissue while posing no health risks. Ultrasound measurements objectively evaluated changes in adipose thickness, and patients were quite satisfied with the treatment and its outcomes. All reported adverse effects were minor and short-lived, and the research did not find any serious problems [32].

## CONCLUSION

Application of both the LLLT and ND; YAG laser had a good effect in treating abdominal obesity in females following gastric bypass, according to the study's scope, conclusions, and limitations. This study's findings provide

credence to the hypothesis that low-level laser and ND: YAG laser treatments can significantly reduce abdominal circumference (ACM) in centimeters, body fat mass (BFM) in kilograms, and ultrasonographic fatty pad depth (FPD) in centimeters. On the other hand, the ND: YAG laser outperformed the low-level laser.

## ACKNOWLEDGMENT

The authors greatly appreciated the patients who participated in this study.

## CONFLICT OF INTEREST

The authors stated no conflict of interest.

## FUNDING

This study received no external funding.

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