# Role of carboxytherapy in localized lipolysis: a clinical and radiological study

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**Background**
Localized obesity is a result of accumulation of adipose tissue present in small quantities in specific area. It is an important issue to search for novel noninvasive fat elimination modalities which help in body contouring.
**Objective**
To estimate the efficacy as well as safety of subcutaneous injection of $CO_2$ in management of localized fat deposits.
**Patients and methods**
This interventional study was conducted on 34 females)22–45years old) having localized fat deposits in abdomen, chin, arm, and thigh. For all history and clinical examination including circumferential tape measurements were done. Digital photographic registration and ultrasound measurements of subcutaneous fat thickness, as well as circumferences of the treated areas before and after eight carboxytherapy sessions (once/week) were performed.
**Results**
There were observed improvement in carboxytherapy treated areas (abdomen, chin, arm, and thigh) in all studied subjects indicated by significant decrease in circumferences of abdomen ($P<0.0001$), arms ($P=0.0003$), and thighs ($P<0.0001$), and ultrasound fat thickness measurements in abdomen ($P\leq0.0001$), chin ($P=0.012$), arms ($P=0.0004$), and thighs ($P<0.0001$). This improvement was achieved in arm ($P=0.0004$) and chin ($P=0.012$) better than abdomen and thighs. Half of our patients (17, 50%) recorded an excellent degree of satisfaction, the highest satisfaction rate was among patients who had lipolysis in the chin region ($P=0.027$). Pain (mild and moderate) and ecchymosis were the only observed adverse effects.
**Conclusion**
Carboxytherapy may be an effective method that could be used in the management of localized obesity, without remarkable adverse effects. Treatment of localized obesity by $CO_2$ sessions once weekly for 8 weeks has a significantly better outcome in arms and chin than in abdomen and thighs.

**Keywords:**
carboxytherapy, localized adiposity, ultrasound measurement

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## Introduction

Obesity is considered a thoughtful health problem that resulting in major morbidity and mortality. A lot of people spend many hours in exercising and they are trying countless kinds of diet regimens, but their obesity residues in some areas. As the population grow and gain weight increased, the prevalence of surgical and nonsurgical techniques for body sculpting has amplified, especially in the latest years [1]. Lipoplasty is a surgical technique that remains a popular procedure for body contouring for those demanding substantial fat lessening. However, the annual number of lipoblast processes performed has reduced dramatically because many patients search for less invasive approaches of body shaping [2].

There are many complications as well as morbidity and mortality associated with liposuctions. Mortality is mostly caused by embolism, necrotizing fasciitis, complications of anesthesia, and hypovolemic shock. Noninvasive alternatives to liposuction include many methods such as radiofrequency ablation, cryolipolysis, laser therapies, high intensity nonthermal (mechanical) focused ultrasound (US), injection lipolysis, and carboxytherapy [2].

Carbon dioxide therapy (CDT) also known as carboxytherapy is the administration of carbon dioxide gas transcutaneously for therapeutic needs. Transcutaneous administration of $CO_2$ could be achieved by; percutaneous methods including $CO_2$

masks, showers and baths, and injection methods including intradermal and subcutaneous $CO_2$ injection [3]. CDT is not a new procedure in the medical field. It was used in France Royal Spa during the 1930s. In which, bathing in a hot carbonated water facilitated speeding up wound healing. In the 1950s, cardiologists used this technique for management of peripheral arterial occlusive diseases, and some disorders caused by poor blood circulation as well as fat deposition in the arterial walls [4].

In the field of dermatology, many researchers have demonstrated that carboxytherapy improves cutaneous circulation and skin elasticity as well as the appearance of wrinkles and fine lines. Moreover, it destroys localized fatty deposits and helps in collagen repair [5].

The role of carboxytherapy as a body contouring tool that was mediated through its lipolytic effect, was investigated in different population [6,7]. However, little is known regarding this issue in Egyptian population. Therefore, we aimed by this work to study the possible effects and side effects of CDT in treatment of lipodystrophy in a sample of Egyptian population.

## Patients and methods

The current interventional study was carried out on 34 volunteer females suffering from localized fat deposits in abdomen, chin, arm, and thigh areas. They were selected from the Outpatient Clinic of Dermatology, Faculty of Medicine, Menoufia University Hospitals, during the period from July 2017 to January 2018. Each participant signed a written informed consent before joining the study. This study was approval by the Research Ethics Committee, Faculty of Medicine, Menoufia University.

We included any subject more than 18 years old, complaining of localized fat deposits in different body areas and having no history of previous treatment (at the last 6 months) for their localized fat deposition. However, those having BMI more than 30, significant concomitant illness (e.g. renal, cardiac, autoimmune conditions, bleeding disorders, and diabetes mellitus), and those under treatment with carbonic anhydrase inhibitors (e.g. acetazolamide and clofenamide) were excluded. We also excluded pregnant and lactating females. All participants were instructed not to use any other methods of body weight reduction or body contouring during the whole duration of the study.

Each individual in the study was subjected to clinical examination including BMI [the weight in kilogram (kg) was divided by height square ($m^2$)] [8].

We used tape measure for circumferential measurements as follows: the abdomen circumference was taken in a line midway between anterior superior iliac spine and the umbilicus. The maximum circumference for each arm circumference was assessed by standardization of distance from the acromion process. Regarding thighs, the circumference was taken at the level of widest girth with standardization of distance from the anterior superior iliac spine. Then the means for both arms and thighs were calculated [7].

Photographing documentation was performed using digital camera canon (PowerShot A2200 HD, 14 MP, 4Xoptical Zoom, Tokyo, Japan), set at a fixed distance from the patients. Two photos (frontal and lateral views) were taken.

By a single investigator, US model Philips (HD11XE; Via Del Rio, Yorba Linda CA, USA) was used for measurement of subcutaneous fat. All US images have been taken while patients were in a supine position. Along the areas to be measured, the probe has been slipped in a regular and slow speed from the distal to the proximal direction. In the abdomen, measurement was taken in a line midway between the anterior superior iliac spine and the umbilicus. Regarding arm and thigh assessments, the measurement was taken at a level of maximum circumference for each evaluated area, and the maximum thickness was recorded. These pretreatment assessed points were reevaluated in all treated regions after treatment sessions.

Each patient in the study received carboxytherapy sessions, once per week for 8 weeks, or till improvement which is first. A programmable Automatic Carbon Dioxide Therapy apparatus (Arab Medical, China) and 30 G; 13 mm needle were used.

### Injection method

#### *Anesthesia*

The ethyl alcohol was used to clean the skin then topical anesthetic cream (lignocaine cream; Nile Company, Cairo, Egypt) was applied (under occlusion) for 30 min.

#### *Prepare the carbon dioxide therapy apparatus*

The device was automatically calibrated to adjust the rate of the gas, through regulation of infusion pressure,

and the dosage of $CO_2$ in cubic centimeter. The infusion velocity consequently was adjusted to be 100 ml/min. The total amount of the infused $CO_2$ was 50–100 ml for chin and arm, 200–300 ml for thigh and 300–600 ml for abdomen. The overall amount of installed gas in treated body areas ~200–1000 ml per session.

*The session was performed as follows*

While our patient was in setting or supine position we hold the needle at a 45-degree angle, pinched the fat, lifting it up away from any underlying muscle, inserting the needle by all its length (13 mm), and holding it steady in place with nondominant hand, then depressing the foot pedal on the carboxy device to start the regulated flow of $CO_2$. The infiltration points were marked respecting the limit of 2 cm equidistant between them. At each point, 10 ml was injected per session.

*Postinjection care*

The patients were advised to avoid any tight clothes on the treated area, and exhausting exercise in the same day of treatment, in addition to drinking plenty amount of fluids to help get out of the injected $CO_2$ [9].

### Assessment of the treatment efficacy

One week after the last session, the efficacy of therapeutic procedure was evaluated by: (a) photographic evaluation, (b) circumference measurements at the pretreatment specific locations, (c) US measurements of thickness of subcutaneous fat, and (d) patient's satisfaction; the degree of improvement concerning patient's opinion was estimated as follows: no improvement: 0 improvement; poor: 1–25% improvement; fair: 26–50% improvement; good: 51–75% improvement and excellent: 76–100% improvement.

Regarding safety assessment, all undesirable effect, that may be noticed by the doctor or observed by the patient, were considered adverse effect. The patients were advised to report any noticed complications such as itching, pain, and/or bruises.

### Statistical analysis

Results were analyzed and tabulated. Microsoft Excel, version 7 (Microsoft Corporation, New York, New York, USA) and SPSS, version 16 (SPSS Inc., Chicago, Illinois, USA) were used. We performed two types of statistics: descriptive statistics: for example, mean, SD, percentage (%) and median, and analytical statistics including the paired *t* test to compare paired numerical data, one-way analysis of variance with application of the Tukey–Kramer test for post-hoc comparison if needed to compare independent numerical data. Graphs were used to illustrate simple information. A *P* value of less than 0.05 was an indicator statistical significance.

## Results

Our studied cases were 34 women their age, BMI, and the sites of localized fat deposits were demonstrated in Table 1. All of the treated cases ($n$=34) received eight sessions.

There was an observed improvement in all treated areas including; abdomen (Fig. 1), thighs, arms, and chin areas (Fig. 2). Based on tape measurements, these improvements were statically significant regarding abdomen ($P$<0.0001), thighs ($P$<0.0001), and arms ($P$=0.0003) (Table 2). Additionally, the US images in the injected areas demonstrated a significant reduction (Figs 3 and 4) in subcutaneous fat thickness abdomen ($P$<0.0001), chin ($P$=0.012), arms ($P$=0.0004), and thighs ($P$<0.0001) (Table 2).

Fat reduction was significantly higher in arm circumferences (7.9±2.3) followed by thigh (7.2±2.1) and ended by the abdominal area (4.1±1.9) ($P$=0.001). The decreased fat thickness (US) was observed in chin (60.6±10.1) followed by thigh (43.03±11.0) then abdomen (34.7±15.2) and finally the arm (25.8±6.7) ($P$=0.001) (Table 3).

Regarding patients' satisfaction, 1 week after the last session, half of our patients (17, 50%) were rating their satisfaction as excellent, with a statistically significant difference among the patients according to the treated region ($P$=0.027), where the highest satisfaction rate was among patients who had lipolysis in the chin region (100%) (Table 4).

Concerning the reported adverse effects, pain was the main complain of all studied subjects. It ranged from

**Table 1 Personal data of studied subjects and distribution of fat deposits in their body areas**

| | |
|---|---|
| Age (years) | |
| Range | 22–45 |
| Mean±SD | 34.7±6.9 |
| BMI (kg/m$^2$) | |
| Range | 26–29.3 |
| Mean±SD | 27.5±1.5 |
| Injected region [*n* (%)] | |
| Abdomen | 13 (38.2) |
| Chin | 5 (14.7) |
| Arms | 6 (17.6) |
| Thighs | 10 (29.4) |

**Figure 1**


(a, b) Abdominal circumference before treatment was 110 cm. (c, d) Abdominal circumference after treatment became 105 cm.

mild to moderate, and occurred at time of session and subsided 1 h after injection without any analgesics. Also, ecchymosis was reported by some patients ($n$=10) and after some sessions.

## Discussion

Localized adiposity is a result of the accumulation of adipose tissue present in small quantities in specific area including lower abdomen, thigh, arm, and chin [10]. Regarding the sites of localized fat deposits in our participants, 13 (38.2%) participants have localized fat deposits in the abdomen, 10 (29.4%) in the thighs, six (17.6%) in the arms, and five (14.7%) participants have fat deposits in their chin areas. However, Hasengschwandtner [11] on a study done on 441 patients found that 122 (28%) of the participants have localized fat deposits in the abdomen, 29 (6%) in the inner thighs, 20 (4%) in double chin and face. This difference may be attributed to genetic variation or habitual differences that may affect fat distribution in human body.

Management of localized fat adiposities is difficult and not satisfactory, many modalities were proposed to treat lipodystrophy such as liposuction, injection lipolysis, and electric stimulation. The effective therapeutic role of CDT in dealing with localized fat deposition was demonstrated through measurable decreases in the circumference of different body regions including the thigh, abdomen, and knee [12]. The authors showed some histological changes indicating the effects of $CO_2$ gas injection on the subcutaneous adipose tissue and their potential lipolytic properties.

In line with the result of Brandi *et al.* [13], we observed a significant improvement in all CDT treated areas including abdomen and thighs after eight sessions of CDT. Confirming this result Lee [6], used carboxytherapy for targeting lipodystrophy on 110

**Figure 2**


(a) Lipodystrophy in submental area before treatment. (b) Lipodystrophy in submental area after treatment showing marked improvement. (c) Arm circumference before treatment was 38 cm. (d) Arm circumference after treatment became 35 cm. (e) Thigh circumference before treatment was 74 cm. (f) Thigh circumference after treatment became 67 cm.

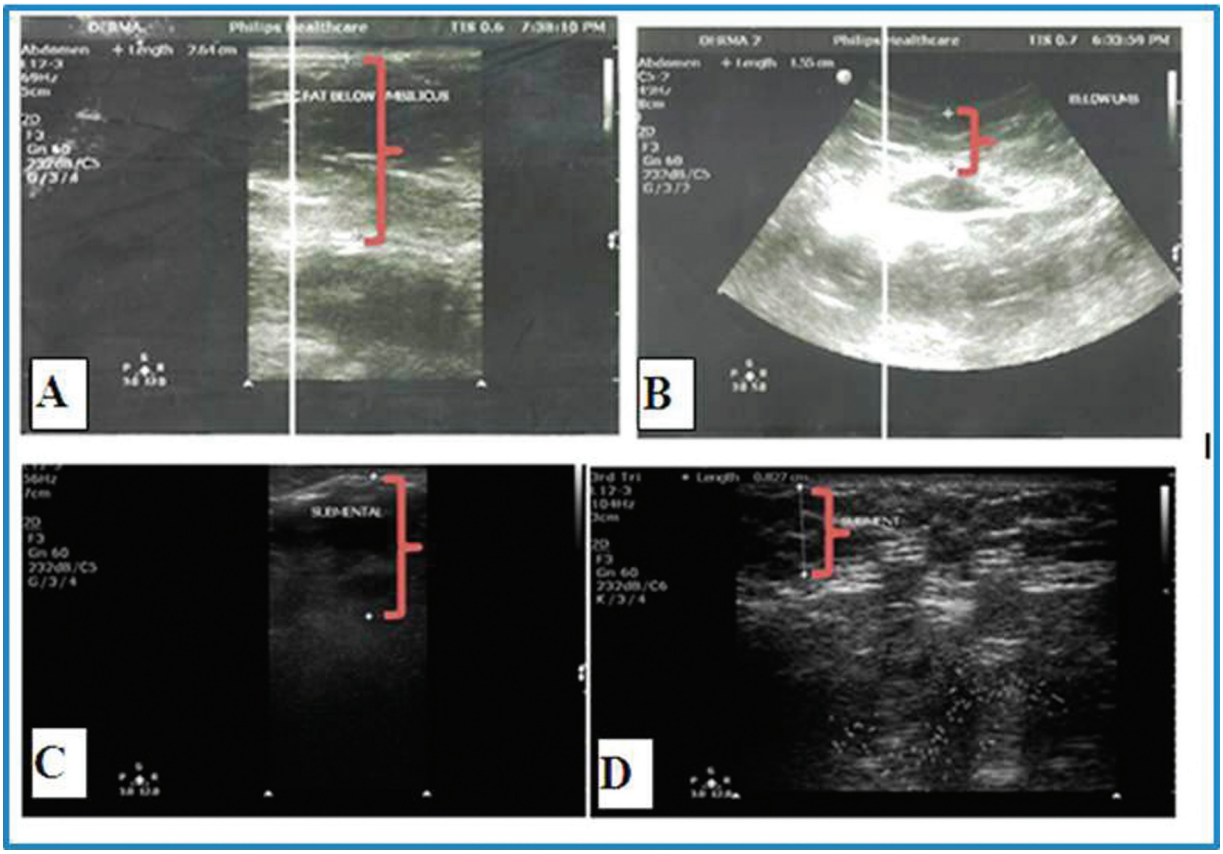
female subjects, they noticed a significant decline in abdomen circumference (upper, lower, and mid). Recently, the author treated 10 patients having localized fat deposited in their abdomen. He also reported a significant drop in lower abdominal circumference after eight sessions of subcutaneous $CO_2$ injection ($P<0.01$) [7], in agreement with Hasengschwandtner [11] we found that a significant reduction in fat deposits in chin area after eight sessions of carboxytherapy one session/week.

**Table 2 Fat deposits before and after carboxytherapy in the treated areas**

| | Carboxytherapy | | Paired *t* test | |
|---|---|---|---|---|
| Treated area | Before | After | *t* | *P* value |
| Abdomen | | | | |
| Circumference (cm) | 109.0±4.4 | 104.5±5.6 | 8.3 | <0.0001* |
| Fat thickness (cm) | 3.30±0.998 | 2.13±0.74 | 7.413 | <0.0001* |
| Arms | | | | |
| Circumference (cm) | 36.2±2.5 | 33.3±2.9 | 9.220 | 0.0003* |
| Fat thickness (cm) | 1.89±0.10 | 1.40±0.08 | 8.538 | 0.0004* |
| Thighs | | | | |
| Circumference (cm) | 67.6±17.0 | 62.9±16.4 | 9.945 | <0.0001* |
| Fat thickness (cm) | 2.77±0.75 | 1.59±0.57 | 8.667 | <0.0001* |
| Chin | | | | |
| Fat thickness (cm) | 1.98±0.90 | 0.75±0.36 | 4.354 | 0.012* |

*Significant difference ($P<0.05$).

**Figure 3**



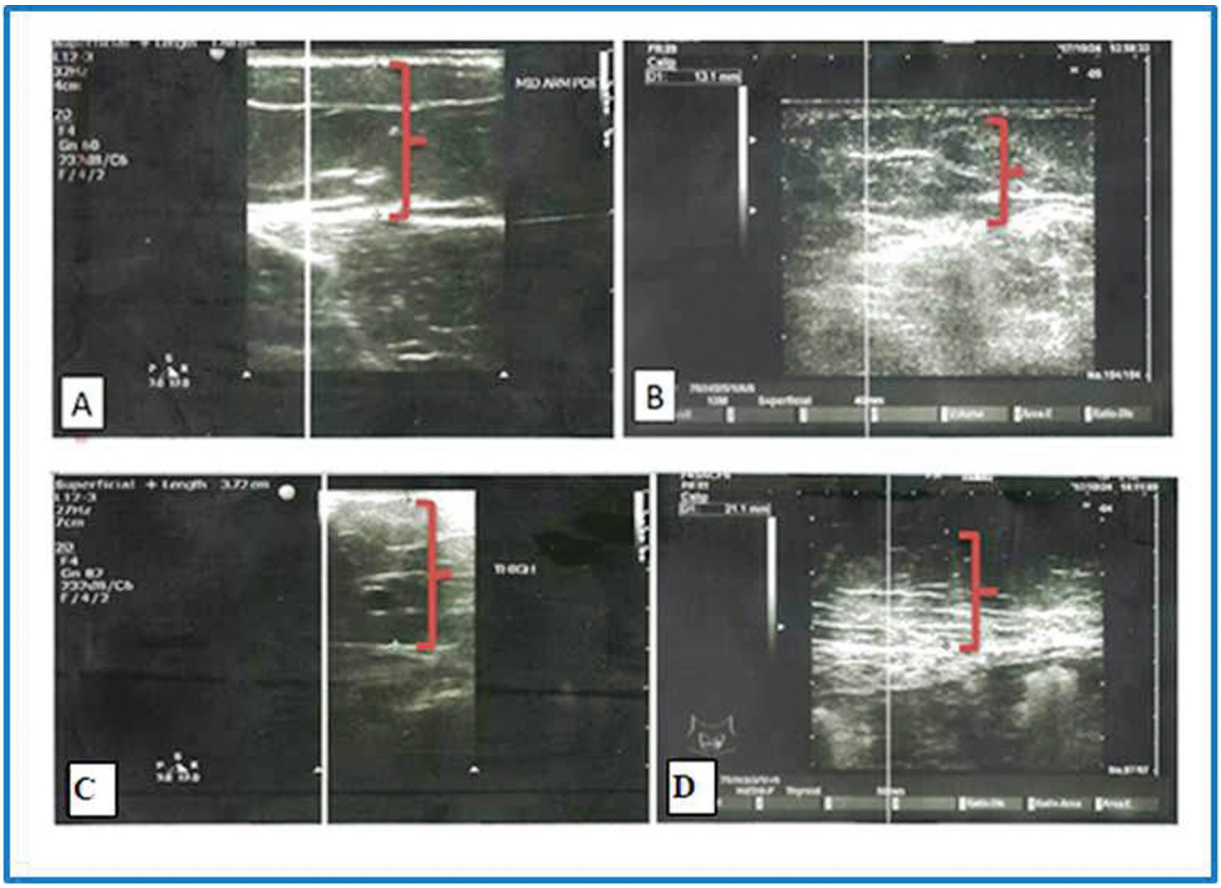

(a) Abdominal subcutaneous fat thickness (US) before carboxytherapy was 2.64 cm. (b) Abdominal subcutaneous fat thickness (US) after carboxytherapy became 1.55 cm. (c) Chin subcutaneous fat thickness (US) before carboxytherapy was 2.87 cm. (d) Chin subcutaneous fat thickness (US) after carboxytherapy became 0.827 cm. US, ultrasound.

Additionally, arm circumferences and their fat thickness were significantly decreased in our studied subjects. These findings confirmed the previously reported effects of carboxytherapy on rat arms [14]. However, Lee [7] found that the reduction of the upper arm circumference after carboxytherapy was nonsignificant: This discrepancy could be explained by lower number of treated cases in Lee study ($n$=10).

Regarding the thigh circumference, the result of the current study was in accordance with that of Lee [6] and Lee [7] who stated that there was a significant reduction in lower limb girth measurements after carboxytherapy (eight sessions/week).

Parallel to results of US measurement of subcutaneous fat wideness in the current work, Pianez *et al.* [15] used panoramic US to estimate the outcomes of the

**Figure 4**




(a) Arm subcutaneous fat thickness (US) before carboxytherapy was 1.88 cm. (b) Arm subcutaneous fat thickness (US) after carboxytherapy became 1.31 cm. (c) Thigh subcutaneous fat thickness (US) before carboxytherapy was 3.72 cm. (d) Thigh subcutaneous fat thickness (US) after carboxytherapy became 2.11 cm. US, ultrasound.

**Table 3 Comparison of the percentage of fat reduction by tape measures and ultrasound in treated body regions**

| Percentage of reduction | Injected region | | | Chin (*N*=5) | *F* (d.f.=2.26) | *P* value |
|---|---|---|---|---|---|---|
| | Abdominal (*N*=13) | Arm (*N*=6) | Thigh (*N*=10) | | | |
| Circumference by measure tape (cm) | 4.1±1.9 | 7.9±2.3 | 7.2±2.1 | – | 9.587 | 0.001* |
| Subcutaneous fat thickness by US (cm) | 34.7±15.2 | 25.8±6.7 | 43.0±11.0 | 60.6±10.1 | 8.389 | <0.001* |

d.f., degree of freedom; *F*, analysis of variance test; US, ultrasound. *Significant difference ($P<0.05$).

treatment of localized fat depositions. They found a significant reduction in subcutaneous fat. In addition, they reported an improvement in the fibrous lines organization within subcutaneous tissue.

The role of carboxytherapy in lipolysis is still controversial. Although, Kikuchi *et al.* [12] found that hypercapnia accelerates adipogenesis leading to excess adiposity, the lipolytic effect of $CO_2$ injection was explained by many investigators. The local application of $CO_2$ can enhance peripheral circulation and improve tissue perfusion. Also it can increase oxygen partial pressure through reflex vasodilation, and stimulate the neo-angiogenesis [15]. Another aspect that may participate in the effective character of carboxytherapy in the management of localized obesity is the shrinkage of adipocytes and reduction in their density in the carboxytherapy treated area [16]. Moreover, Brandi *et al.* [13] studied the histological changes after local application of $CO_2$ and reported damage of fat cells with subsequent release of triglyceride in the intracellular spaces. They demonstrated adipocytes that were presented with thin fractured outlines. These observed lines in the adipocytes plasma membranes did not involve the connective tissue spaces where the major vascular structure are located.

In the current study, we demonstrated that the reduction in circumferences of the treated area was significantly higher in the arm circumference followed by the thigh and ended by the abdomen. Additionally,

**Table 4 Degree of patients' satisfaction according to different sites of lesions**

| Degree of patients' satisfaction | Treated region [*n* (%)] | | | | Total | *P* value‡ |
|---|---|---|---|---|---|---|
| | Abdomen | Chin | Arm | Thigh | | |
| Excellent | 9 (69.2) | 5 (100) | 1 (16.7) | 2 (20.0) | 17 (50.0) | 0.027* |
| Good | 2 (15.4) | 0 (0.0) | 3 (50.0) | 5 (50.0) | 10 (29.0) | |
| Fair | 1 (7.7) | 0 (0.0) | 2 (33.3) | 3 (30.0) | 6 (17.6) | |
| Poor | 1 (7.7) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (2.9) | |
| Total | 13 | 5 | 6 | 10 | 34 (100) | |

‡$\chi^2$ test. *Significant difference ($P<0.05$).

thickness of subcutaneous fat measured by US was observed in chin followed by the thigh then the abdomen and finally the arm. The observed significant better outcome in arms and chin area than in abdomen and thigh could be explained by the small amount of fat in these areas compared to thighs and abdominal wall.

We observed a significant improvement in skin cellulite specially in both thighs. Likewise, Pianez *et al.* [15] found a significant improvement of the cellulite and reduction of its severity from degree III to degree II. Additionally, they reported a significant association between this improvement with the improvement in the fibrous lines organization and the dumping of adipose tissue in $CO_2$ treated areas.

Regarding the patients' satisfaction, at the end of treatment sessions ($n$=8) half of our studied patients achieved an excellent degree of satisfaction specially those having lipolysis in the chin region. However, in a study done by Pianez *et al.* [15] all their studied individuals showed an excellent satisfaction after CDT. This difference could attributed to genetic factors and social background of the treated subjects that may affect amount of fat deposits.In the current study, minimal side effects were recorded including ecchymosis and pain. Therefore, we suggested that CDT is a safe technique. Supporting our speculation, Lee [6] found minor adverse effects including crepitus and pain at sites of injection, in addition to minor aches. All of these adverse effects last less than half an hour. Also, Pianez *et al.* [15] performed 80 sessions with carboxytherapy. They observed that no one of their participants developed any kind of significant side effects. The authors observed a mild transient discomfort during $CO_2$ injection, and only one of their treated subjects had small bruises which spontaneously resolved. Regarding the long-term effect of carboxytherapy in management of localized fat deposition, Alam *et al.* [17]) found that carboxytherapy provides a transient decrease in subcutaneous fat that may not persist at week 28. However, in the current study, the main limitation was lack of long-term follow up. Also, small number of studied subjects was considered a limitation of this work. Therefore, we recommended large scale study with long-term follow up to assess the carboxytherapy maintenance regimen in localized obesity management program.

## Conclusion

Based on the result of the current study, we might conclude that carboxytherapy is an effective method in the treatment of localized obesity, without remarkable adverse effects. Treatment of localized obesity by $CO_2$ sessions once weekly for 8 weeks has a significantly better outcome in arms and chin than in abdomen and thighs.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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