

Carbon Dioxide Therapy: Effects on Skin Irregularity and Its Use as a Complement to Liposuction

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Abstract. For a successful conventional or superficial liposuction, it is necessary to consider the competence of the surgeon who is to administer the procedure necessary for this type of surgery as well as the physical and psychological evaluation of the determined patient. A poor result often is related to the persistence of adipose tissue irregularity in the form of fatty tissue accumulation. This complication, common to this type of surgery, has called for research to determine methods for its treatment. Carbon dioxide (CO₂) therapy refers to the transcutaneous and subcutaneous administration of CO₂ for therapeutic purposes. This treatment originated at the Royal Spas of France in 1932 with the treatment of patients affected by obliteration of arteriopathies. Recent studies have demonstrated the effect of subcutaneous CO₂ therapy performed to improve local parameters of circulation (performed by Doppler, laser-Doppler, and trans-cutaneous partial pressure of oxygen determination), and to reduce localized adiposities (verified reporting variations in maximum circumference and performing histologic studies). With these results, the absence of toxicity, and the relevant side effects related to this treatment taken into consideration, the Plastic Surgery Unit of Siena has been committed to researching the role that CO₂ therapy can play in the treatment of skin irregularity and as a complement to liposuction. The authors report their experience using Carbomed programmable automatic CO₂ therapy apparatus and 30GA1/2 0,3X13 microlance needles for the treatment of patients with adipose tissue accumulations located on the thighs and knees. In their study, 42 patients were divided into three groups: A, B, and C. In Group A, only liposuction was performed. In group B 3 weeks after liposuction CO₂ therapy was administered in two weekly sub-

cutaneous applications of CO₂ for 10 consecutive weeks. In group C, CO₂ therapy alone was administered with the same contingencies used for group B (two weekly subcutaneous applications of CO₂ for 10 consecutive weeks). The objective was to assess the effectiveness of CO₂ therapy for skin irregularity and as a complement to liposuction for adipose tissue accumulation by reporting variations in circumference and skin elasticity monitored by the Cutometer SEM 474 in all treated areas. The data obtained were analyzed statistically. Values of *p* less than 0.05 were considered significant. The authors report their experience and the results achieved from the study.

Key words: Carbon dioxide—Liposuction—Skin elasticity

For a successful conventional or superficial liposuction, it is necessary to consider the competence of the surgeon and his ability to perform the appropriate procedure as well as a thorough physical and psychological evaluation of the determined patient. The location of the adiposity is of major importance for successful analysis of the determined subject.

The patient’s physical demographics such as age, weight, and skin type also are of major relevance, as well as psychological factors such as the patient’s needs and expectations [8,14]. The latter has consistently proved to be the most problematic. Patients have been dissatisfied because of the negative symptoms associated with the persistence of skin irregularity in the form of adipose tissue accumulation. To date, this problem has not been rectified.

The negative physical characteristics associated with fat accumulation and obvious skin irregularity has called for further research to determine the most favorable treatments. There have been many proposed methods, but the results have not been proved in experimental and clinical practice [5,6]. Alternative

Table 1. Measurement of circumference

| | Before surgery (cm) | After 3 weeks (cm) | After 2 months (cm) |
|----------------------------|---------------------|--------------------|---------------------|
| Group A thigh ^a | 58.9 | 55 | 53.7 |
| Group B thigh ^b | 58.1 | 53 | 51.4 |
| Group A knee ^a | 42.1 | 38 | 37.7 |
| Group B knee ^b | 40.3 | 38 | 36.9 |

^aGroup A, liposuction^bGroup B, liposuction + carbon dioxide therapy

forms of treatment have been used to assist the general recuperation of the patient such as physical exercise (active form), electrostimulation (passive form), changes in eating habits, and lifestyle changes (smoking). All predisposing pathologies (e.g., circulatory and hormonal disturbance) such as physiotherapeutic, medical, and surgical treatments also have been considered.

Carbon dioxide (CO₂) therapy is a new and innovative method for the treatment of skin tissue irregularity. Recent studies have shown the effects of subcutaneous CO₂ therapy accompanied by Doppler, laser-Doppler, and transcutaneous partial pressure of a determination for improving local parameters of circulation and for the reducing localized adiposities (verified by reported variations in maximum circumference and by performing histologic studies) [3,4,9–13]. Throughout this research, the authors observed a positive effect on skin elasticity presumably related to the histologic results obtained for the skin [4]. Considering these results as well as the absence of toxicity and relevant side effects, the Plastic Surgery Unit of Siena studied the effect of CO₂ therapy on skin flaccidity and the role that this treatment can play as a complement to liposuction.

Material and Methods

In this study, 42 patients with adipose tissue accumulations located on thighs and knees were observed. The 24 female patients (average age 41 years) were equally divided in 2 groups (A and B). In group A liposuction was performed. In group B, after 3 weeks of liposuction, CO₂ therapy was administered in two weekly subcutaneous applications of CO₂ for 10 consecutive weeks using a programmable CO₂ therapy apparatus (Carbomed by Laboratory Electronics Designer) and 30GA1/2, 0,3X13 microlance needles. The infusion velocity administered was 100 ml/min, and the total quantity of CO₂ was 300 ml per limb. The remaining 18 patients, in group C (average age, 40 years), were treated with the same contingencies used for group B. Group C was treated solely with CO₂ therapy.

Table 2. Skin elasticity UE/UR measurements before and after treatment^a

| | Mean | Standard deviation | MSE | P Value |
|----------------------|------|--------------------|------|---------|
| Group A ^b | | | | |
| Before | 2.98 | 0.87 | 0.25 | 0.01 |
| After | 4.39 | 1.49 | 0.43 | |
| Group B ^c | | | | |
| Before | 3.2 | 0.98 | 0.28 | 0.005 |
| After | 4.92 | 1.65 | 0.48 | |
| Group C ^d | | | | |
| Before | 2.88 | 0.74 | 0.18 | 0.001 |
| After | 4.48 | 1.56 | 0.37 | |

UE/UR, Immediate Distribution/Immediate Retraction; MSE, Median Standard Error.

^aComparison by Student's *t*-test for paired data

^bGroup A, liposuction

^cGroup B, liposuction + carbon dioxide therapy

^dGroup C, carbon dioxide therapy

Before surgery, and then after 2 months and 20 days, the circumference of the treated areas was measured in both groups A and B. In all 42 patients (groups A, B, and C), both at the beginning and after the final stages of treatment (2 months after surgical treatment), elasticity studies were conducted using Cutometer SEM 474 Courage-Khazaka [1,2,7]. All the patients were examined for a follow-up period of 3 months to monitor the results and identify any side effects. For statistical analysis, a Student's *t*-test of paired data was used. The mean and standard deviation of the results were reported and a *p* value less than 0.05 was considered significant.

Results

The results from the measurement of *thigh* circumference in groups A and B, as shown in Table 1, were 58.9 cm before surgery for group A and 58.1 cm for group B. At 3 weeks after surgery, the results were 55 cm (for group A) and 53.7 cm (for group B). After 2 months, the average measure was 53.7 cm for group A and 51.4 cm for group B. The results from the measurement of knee circumference in groups A and B, as shown in Table 1, were 42.1 cm before surgery for group A and 40.3 cm for group B. At 3 weeks after surgery, the results were 36.9 cm for group A and 38 cm for group B, as compared with 37.7 cm after 2 months for group A and 36.9 cm for group B.

The mean measures and values of the Student's *t*-Test for paired data (Table 2), obtained by measurement of skin elasticity (Immediate Distribution/Immediate Retraction [UE/UR]) for groups A and B before surgery were ± 0.87 for group A 2.98 and 3.2 ± 0.98 for group B mean. At 2 months after surgery, was the mean was 4.39 (± 1.49) ($p = 0.01$) for group A and 4.92 (± 1.65) ($p = 0.005$) for group



Fig. 1. patient group C effect on skin and on adiposity before and after carbon dioxide treatment.

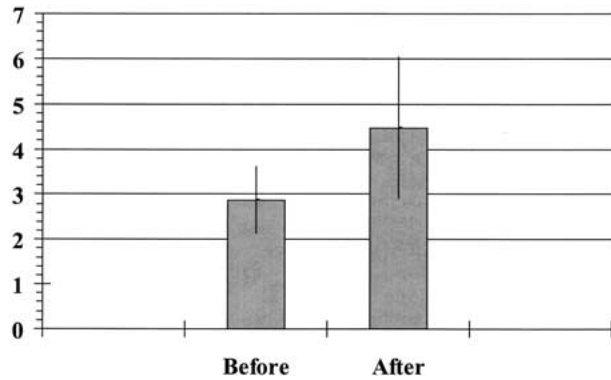
B. The relative increase in medium values of UE/UR (skin elasticity) was 47.5% for group A and 53.8% for group B.

For group C, the mean measurement and values of the Student's *t*-test for paired data, as shown in Table 2, was 2.88 ± 0.74 before treatment (medium standard error, 0.18) and 4.48 ± 1.56 after treatment (medium standard error, 0.37; $p < 0.001$) (Fig. 1). The demonstrated skin elasticity studies, as shown by Cutometer Skin Elastic Measurement (SEM) 474, before and after CO₂ treatment, are shown in Figure 2. In group C, the relative increase in medium values of UE/ER (skin elasticity) was 55.5%. This group shows a more comparable study because the findings refer only to CO₂ therapy alone. Only minimal side effects were observed, and all were quickly resolved. All the patients showed the presence of a crackling sensation beneath the skin, limited to the first hour of CO₂ treatment and 25% of the patients had slight ecchymosis, which disappeared without causing any aesthetic damage. The pain experienced at the area of injection, although frequently observed (55%), was always short lasting and never of such major intensity that gas administration had to be interrupted.

Conclusion

Skin irregularity before or after surgical treatment using liposuction often results in poor satisfaction. In fact, although liposuction allows cutaneous retraction, it is common for some uneven areas to persist. Patients tend to view this postsurgical result as a negative experience to the point of judging the surgery to be unsuccessful. Previous research has shown a positive result in terms of microcirculation and reduction of adipose accumulation associated with CO₂ therapy [4].

This study has shown that with CO₂ therapy to obtain improvement of skin irregularity and cutaneous elasticity is possible. This has led us to consider the possibility of CO₂ therapy as a complement to liposuction. Our study has shown the positive re-



TAB. 3. GROUP 1. Patients group C, study of skin elasticity with cutometer SEM 474 before carbon dioxide treatment GROUP 2. Patients group C, study of skin elasticity with cutometer SEM 474 after carbon dioxide treatment

sponse to reduced fat accumulation. This was confirmed by analysis of the results obtained by measurement of a higher circumference in group B than in group A. Particularly interesting were the effects on skin elasticity. Some of these showed an improvement of this parameter, particularly after a superficial liposuction [8]. For this reason, the effect of CO₂ therapy on skin elasticity, was verified by treating group C with CO₂ therapy alone and group B with both CO₂ therapy and surgical treatment. The results show a statistically significant improvement with regard to skin elasticity in group C, confirming the positive effect of treatment with CO₂ alone on skin elasticity. In the other two groups, the results show that even if group A showed an improvement in skin elasticity, according to literature, the best outcome in terms of skin elasticity has been obtained by combining liposuction and CO₂ therapy. Group B showed higher increase in UE/UR than group A.

In this study, no important side effects were linked to CO₂ treatment. We believe that CO₂ therapy is a safe therapy with no relevant side effects. Because of its lipolytic properties and positive effect on skin elasticity, CO₂ therapy could play a useful role as a complement to surgical liposuction for the treatment of persistent skin irregularity.

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