

Cutometric assessment of elasticity of skin with striae distensae following carboxytherapy

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Summary

Objective: The aim of the study was to evaluate the effectiveness of carboxytherapy in the treatment of striae distensae. Additionally, discomfort and side effects associated with the treatment were assessed.

Materials and methods: This study involved 15 women aged 22–40 years. They underwent 3 sessions of carboxytherapy at one-week intervals. Treatment was performed in skin area within stretch marks located on stomach, buttocks, and thighs. Cutometric probe was used to evaluate skin elasticity. Four measurements were performed—immediately before each treatment and one month after the last session. Photographic documentation was made before and after a series of treatment to perform clinical evaluation of changes in skin condition.

Results: Statistical analysis of results obtained with the use of Cutometer (R2 and R8 parameters) demonstrated that carboxytherapy significantly improved skin elasticity within stretch marks ($P < .05$). The analysis of photographic documentation revealed 58% improvement in stretch mark visibility. The width and length of stretch marks decreased, and their color became more like the natural color of the skin. Carboxytherapy is associated with moderate pain/discomfort. The occurrence of hematoma is the main side effect of this procedure.

Conclusions: Carboxytherapy seems to be an effective method of reducing stretch marks. This procedure is safe, and it can be performed without the risk of complications. Moreover, it does not require special postoperative convalescence. Photographic documentation is a method of assessment of aesthetic procedures effectiveness, which is complementary to other objective methods (eg, the use of MPA probes).

KEYWORDS

carboxytherapy, Cutometer, skin elasticity, striae distensae

1 | INTRODUCTION

The damage of elastic and collagen fibers is observed in the histopathological image of stretch marks, which are also known as linear striae (striae, striae atrophicae, striae distensae). Also the thinning of the dermis and epidermis occurs within such areas. The image of striae resembles a scar.^{1,2} Clinical picture of red and white striae distensae is different. The first type is associated with

inflammatory reaction and vasodilatation. In the next phase of development, purple striae distensae transform into white atrophic lines. In rare cases, they may be accompanied by cracks or ulcers. The reasons for striae distensae may be innate, and they are associated with abnormal skin development and lower resistance of elastin and collagen fibers to mechanical stretching. Also, hormonal changes, pregnancy, puberty, and sudden increase in body fat or muscles affect the development of striae distensae.^{3–7}

The use of chemical peelings, injections (needle and microneedle mesotherapy), radiofrequency procedures, IPL, nonfractional broadband infrared light as well as ablative and nonablative laser therapy seems to be effective in the reduction in striae distensae.¹⁻¹⁵ Due to the fact that the aforementioned methods do not reduce striae distensae completely, scientists and dermatologists are constantly searching for new, effective treatment methods. Carboxytherapy is one of most recent therapies. It involves the injection of carbon dioxide, which results in local hypoxia followed by compensatory vasodilatation and subsequently increased blood supply to the treated area. Carboxytherapy is associated with the thickening of the dermis and the improvement of its elasticity.¹⁶

The purpose of the study was to assess skin elasticity following the use of carboxytherapy in the area of striae distensae.

2 | MATERIALS AND METHODS

2.1 | Materials

The study involved 15 women aged 22-40 (mean age: 27 years) with striae distensae located in the abdomen, buttocks, and thighs. Patients did not use cosmetics and did not perform any other treatments within the treated area before inclusion into this study. An interview was carried out before the treatment to exclude contraindications. Carboxytherapy is safe if severe disorders of organs involved in the metabolism and elimination of CO₂ from the body, such as severe respiratory failure, renal, cardiac and circulatory failure, stroke, anemia, tumors, connective tissue diseases as well as infectious diseases caused among others by anaerobic bacteria, are excluded. Moreover, patients treated with carbonic anhydrase inhibitors were also excluded. All enrolled women provided a written consent to participate in the study, and they were informed about post-treatment procedures to avoid side effects.

2.2 | Methods

Three sessions of carboxytherapy were performed at one-week intervals with the use of a special gun (Concerto, Aurum, France), which allowed for sterile injections of medical carbon dioxide. The procedure involved injection of carbon dioxide into the subcutaneous tissue with the use of thin (4 mm), disposable needles 32G. Prior to procedure, the area with striae distensae was disinfected. The needle was introduced at an angle of 30°-45°, to the depth of 1 mm. Depending on the treatment area, 20-40 mL of CO₂ was used. The depth of needle penetration was controlled by the built-in limiter. The treatment lasted about 15-20 minutes. Three sessions were performed at one-week intervals.

The effectiveness of the treatment was assessed on the basis of cutometric measurements and photographic documentation.

Cutometer MPA 580 (Courag + Khazaka electronic GmbH, Germany), which was used to assess the elasticity of the skin, operates on the basis of a suction method. The use of vacuum-dependent suction deforms mechanically the skin. The skin is absorbed into a

small, 2 mm in diameter hole. The built-in optical system of a probe allows for the measurement of the depth of skin suction. When the skin is sucked into the hole, the intensity of light transmitted to the receptor changes and the measurement result is presented in millimeters. The following measurement parameters were used in this study: measurement mode: 1, negative pressure: 450 mbar, on-time: 3 seconds, off-time: 3 seconds, 3 repetitions. R2 and R8 parameters were measured. Parameter R2, which reflects the ratio of total skin elasticity to total stretch (Ua/Uf), is the most commonly measured parameter of skin aging evaluation. Parameter R8 describes the ability of skin to return to its original state, that is, =Ua. Measurements were performed before each treatment (three measurements in total) and also 1 month after the third treatment, in three different places within the middle part of the stretch mark.

The photographic documentation was prepared with the use of FotoMedicus photographic system and Canon EOS camera with zoom control. Pictures were taken in a standing position. The lighting conditions were standardized and repetitive while taking each picture. Three independent researchers compared clinical changes before the series of treatment and 1 month after the last procedure.

The research project and procedures were approved by the Bioethics Committee of the Medical University of Lodz (Protocol No RNN/165/16/EC).

3 | RESULTS

The results of R2 parameter analysis revealed significant differences between individual measurements. First favorable changes were observed after the third treatment. The comparison of measurement 1 (before the treatment) with measurement 4 (1 month after the last treatment) demonstrated a permanent, statistically significant improvement in skin elasticity in 15 women with striae distensae ($P = .0008$). In all patients, the comparison of measurements 1 and 2, 1 and 3, 1 and 4 showed a progressive, statistically significant improvement of R2 values (P1R2 to P3R2 $P = .004$, P1R2 to P4R2 $P = .0008$). In all patients, the analysis of the results of R8 parameter measurements demonstrated a significant difference between the pretreatment and post-treatment values (comparison between measurements 1 and 4, $P = .003$). The comparison of R2 and R8 values obtained in 1st measurement (before series of treatment) and 4th measurement (performed 1 month after the last treatment) showed a permanent, significant improvement in skin elasticity in 15 participants ($P < .05$). The greatest improvement in all measurement sites was seen after the series of treatment. The results of the measurement of R8 parameter were not as significant and stable as in the case of R2 analysis [Figure 1, Table 1].

Results are expressed as mean and standard deviation (mean \pm SD). The variability in measured parameters (R2, R8) at each time point was analyzed using the Student's *t* test. Pearson correlation was used to analyze the relationship between the results.

Three independent specialists performed clinical assessment on the basis of photographic documentation [Figure 2]. They compared

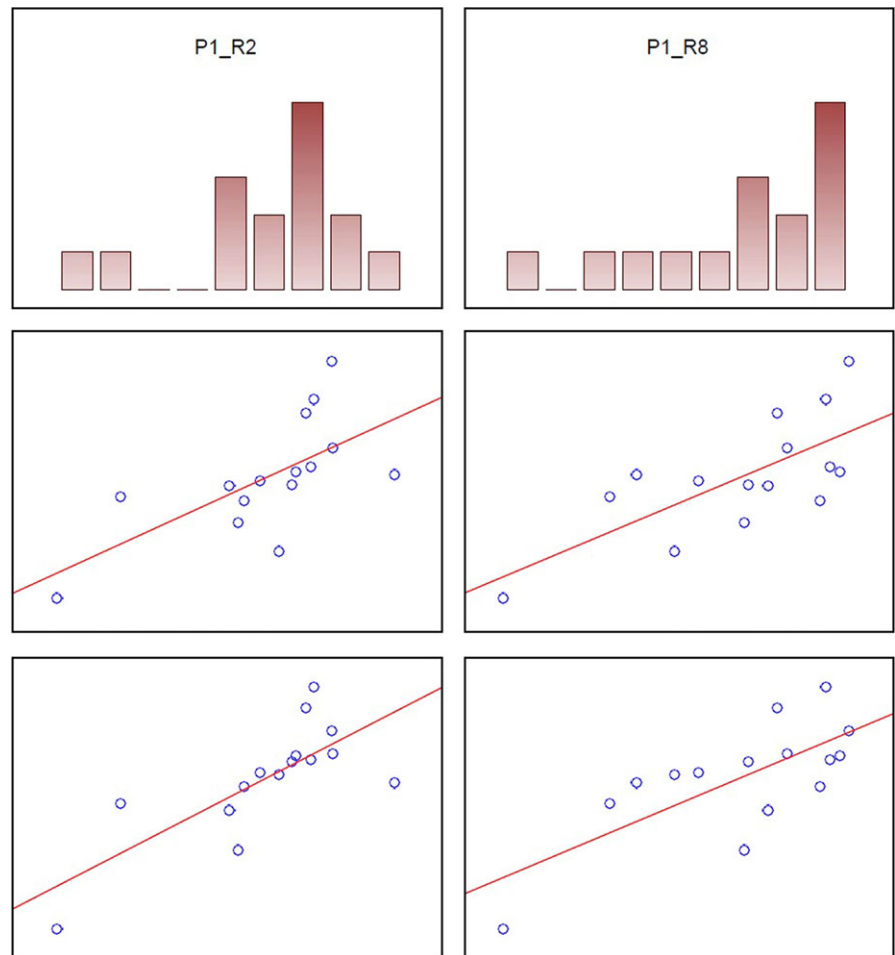


FIGURE 1 The results of the measurement of R8 parameter were not as significant and stable as in the case of R2 analysis

pictures taken before the series of treatment with those taken a month after the last procedure. During the evaluation, they paid particular attention to the improvement of striae distensae color (whether their color has become more similar to natural color of skin) as well as the reduction in the width, depth, and length of striae distensae. Striae distensae were found to be less visible and to be reduced by mean of 58% following the procedure. Moreover, the use of carboxytherapy was associated with the reduction in striae distensae length by 44.5%, depth by 66%, and width by 54.5%. Also, 67.8% improvement in striae distensae color, which has now become more similar to natural color of surrounding skin, was observed. In all patients, the observed changes were considered as favorable.

During the treatment, patients felt burning and pain which was not, however, strong enough for patients to ask to stop the procedure. During and after the procedure, crackling sensation under the skin was observed, which is characteristic for carboxytherapy and is associated with intradermal and/or subcutaneous accumulation of gas. All subjects suffered from slight side effects in the form of redness which usually persisted up to 1 hour after the procedure and bruises within the injection site, which lasted up to 7 days after procedure. In nine patients, excessive tenderness was observed but it disappeared after 3-12 hours after the procedure.

4 | DISCUSSION

In literature, there are few reports regarding objective evaluation of striae distensae reduction following carboxytherapy. In this study, Cutometric measurements demonstrated improved skin elasticity within striae distensae, which may be associated with the remodeling of collagen and elastin fibers. The improvement of skin density is a result of the stimulation of fibroblasts to produce new collagen. Brandi C et al study involved 48 women with excessive fat accumulation within thighs, knees, and abdomen who underwent six sessions of carbon dioxide therapy (twice a week for 3 weeks). The use of this procedure was associated with enhanced blood flow and ameliorated skin oxygenation assessed on the basis of Doppler examination. Moreover, in their study, histological examination revealed the increase in collagen fiber diameter and increased thickness of dermis, which resulted in improved skin density and tension (the pattern of new collagen was characteristic for young skin).¹⁷ In a subsequent study, Brandi C. et al analyzed the effect of carboxytherapy on the skin in a group of 42 women with excessive accumulation of fat around thighs and knees who underwent liposuction (group A), liposuction, and carboxytherapy (group B) or only carboxytherapy (group C). Carboxytherapy in groups B and C was performed twice a week for 10 weeks (total of 20 procedures).

TABLE 1 In all patients, the comparison of measurements 1 and 2, 1 and 3, 1 and 4 showed a progressive

Correlations				
Marked correlation coefficients are significant $P < .05000$				
N = 15				
	P1R2	P2R2	P3R2	P4R2
P1R2	1.0000	.8037	.7715	.7541
	$P = \text{—}$	$P = .000$	$P = .001$	$P = .001$
P2R2	.8037	1.0000	.7109	.8629
	$P = .000$	$P = \text{—}$	$P = .003$	$P = .000$
P3R2	.7715	.7109	1.0000	.5553
	$P = .001$	$P = .003$	$P = \text{—}$	$P = .032$
P4R2	.7541	.8629	.5553	1.0000
	$P = .001$	$P = .000$	$P = .032$	$P = \text{—}$
	P1R8	P2R8	P3R8	P4R8
P1R8	1.0000	.3346	.2682	.7127
	$P = \text{—}$	$P = .223$	$P = .334$	$P = .003$
P2R8	.3346	1.000	.4087	.5318
	$P = .223$	$P = \text{—}$	$P = .130$	$P = .041$
P3R8	.2682	.4087	1.0000	.3476
	$P = .334$	$P = .130$	$P = \text{—}$	$P = .204$
P4R8	.7127	.5318	.3476	1.0000
	$P = .003$	$P = .041$	$P = .204$	$P = \text{—}$



FIGURE 2 Photographic documentation

Apart from the evaluation of fat reduction, they assessed skin elasticity with the use of Cutometer. In group C (treated only with carboxytherapy), a significant improvement in skin elasticity (by 55%) was observed. In turn, improvement of skin elasticity by 47.5% was demonstrated in group A and by 53.8% in group B.^{18,19} In our study, cutometric analysis revealed the amelioration of skin elasticity, which may be associated not only with increased production of collagen but also elastin both leading to the increase in mechanical properties of the skin. Pinheiro et al study compared the effects of carboxytherapy and radiofrequency procedures on the skin within

abdomen area in 8 persons subjected to abdominoplasty. Carboxytherapy was performed on the right side of the lower abdomen while RF on the left side. Additionally, a control test was performed on the untreated skin. Biopsy of these three areas was performed to evaluate effects of treatment in an objective manner. The histopathological examination showed the reconstruction of collagen fibers. Moreover, a greater increase in the amount of elastin fibers was observed after carboxytherapy than after radiofrequency.²⁰

In our study, we observed a change in skin color within striae distensae—the color became closer to the natural skin tone. This change may be related to the appearance of a network of new blood vessels within skin, which exerts a direct effect on its color. Fioramonti P et al study which involved 90 persons analyzed the impact of carboxytherapy performed within eye area on the reduction in signs of aging, such as wrinkles and bruises under the eyes. The treatment was performed one time per week for 7 weeks. The assessment of changes was made on the basis of photographic documentation. Fioramonti P et al demonstrated that carboxytherapy significantly reduced (50%-60% improvement) bruises under the eyes and diminished wrinkles.²¹ Valralo V et al²² in their review paper underline that the primary goal of carboxytherapy is to restore and improve cutaneous microcirculation. CO₂ decreases blood pH which in turn leads to tissue hyperoxidation (due to reduced affinity of hemoglobin to oxygen), and further, it results in vasodilatation and related elevation of skin temperature within carbon dioxide injection site (average by 3.48°C). In consequence, tissue perfusion is enhanced while lymph circulation is improved. This is important for tissue drainage and may have an indirect effect on skin appearance. Moreover, the production of tissue growth factors that promote the formation of new capillaries (angiogenesis) is increased, which directly influences skin functioning, including the production of collagen by fibroblasts.^{22,23}

Authors of discussed studies indicate beneficial effects of carboxytherapy on connective tissue and dermal microcirculation, and therefore, it can be used in the treatment of striae distensae, scars, burns, bad healing wound, and loss of skin elasticity, shadows and lymphedema under eyes, and cellulite and the local accumulation of fat. Carboxytherapy can also be used after surgery, for example, after liposuction or surgical removal of excess adipose tissue.^{17-20,24} In our study, all enrolled women felt burning and pain during the procedure, while after the procedure, they reported crackling sensation under the skin, the presence of bruises, and subjective feeling of excessive tenderness. Also, Brandi et al in their study observed similar side effects, including crackling and bruises.^{17,18} Our study revealed considerable increase in skin elasticity, which was surely associated with the increase in skin thickness and the improvement of microcirculation.

5 | CONCLUSION

Carboxytherapy seems to be an effective method used in the stretch mark reduction. It was shown to exert beneficial effects on skin

elasticity which is associated with connective tissue remodeling and the improvement in cutaneous microcirculation. This procedure is also safe, it can be performed without the risk of future complications, and it does not require specific postprocedural convalescence. Photographic documentation is a method of assessment of aesthetic procedures effectiveness, which is complementary to other objective methods (eg, the use of MPA probes).

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DECLARATION OF INTEREST

The authors report no conflict of interest. The authors themselves are responsible for the content and writing of the manuscript.

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