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Review Article

Carboxytherapy – Non-Invasive Method in Dermatology, Aesthetic Dermatology and some other Branches of Medicine

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Introduction

Carboxytherapy- therapeutically applied carbon dioxide injections have been used in balneotherapy since 1932. In the last four years however, this treatment modality has become the centre of attention as a unique method applicable in dermatology, aesthetic dermatology, anti-aging medicine. Many clinics of aesthetic medicine promote this unique method as minimum invasive and non-aggressive, comfortable for the patient and producing excellent effects without the risk of undesired side effects. In aesthetic dermatology this method may be applied as a rejuvenation modality and is employed mainly due to its classic vasodilatation effect and its capacity to foster intradermal collagen restructuring. In classic dermatology it is used to treat patients with poor healing lower leg ulcers, in diabetic patients and in patients with poor healing surgical wounds, is efficient also in small deposits psoriasis when combined with some other traditional

approaches, in circumscription scleroderma, lichen verrucosus as well as hair loss. In aesthetic dermatology the effect is manifest quite soon (usually after two sessions already in the course of 7-14 days). It significantly and visibly improves the tonus of the skin as well as other aesthetic parameters (especially while treating skin laxity in abdomen area, inner arms and thighs, and double chin or saggy eyelids. Good effects also show to treat stretch marks, cellulite, and scars (also older and more extensive scars after burns). Great effects are achieved in correcting the side effects of ill performed interventions such as liposuction, or in using carboxytherapy directly to shape problem body areas (hips and abdomen).

Figure (l): Female patient before the application of carboxytherapy– rejuvenation, to elevate drooping corners of the mouth

Figure (2): The same female patient-Condition after 4 carboxytherapy sessions

Definition

CO_2 is indeed necessary for the human body, just like oxygen, as it stimulates many processes and signals the danger of hypoxia and hypercapnia [1]. The oxygenation of tissues and the bond between O_2 with haemoglobin depend on the content of CO_2 in the human blood (the latter is the weaker the lower the pH). CO_2 maintains the stability of the blood pH, vascular tone, and participates in the biosynthesis of the most important cell components: lipids, carbohydrates, and proteins. Carbon dioxide is a kind of a pacemaker: at high concentrations of CO_2, gas exchange in tissues (CO_2 and O_2) increases and blood circulation improves in the area of its administration (CO_2 is continuously formed in the tissues of the body in the process of metabolism of fats, proteins and carbohydrates (200-250 ml at rest and 1.5 litres per minute under physical stress). It affects the permeability of cell

membranes as well as the activity of many enzymes and hormones. The Bohr Effect is a physiological phenomenon stating that haemoglobin's oxygen binding affinity is inversely related both to acidity and to the concentration of carbon dioxide. An increase in blood CO_2 concentration which leads to a decrease in blood pH will result in haemoglobin proteins releasing their load of oxygen. Conversely, a decrease in carbon dioxide provokes an increase in pH, which results in haemoglobin picking up more oxygen. Since carbon dioxide reacts with water to form carbonic acid, an increase in CO_2 results in a decrease in blood pH. HbO_2 + H+ $\rightleftharpoons$ O_2 + HHb+ Artificially created in tissues alkalosis causes the spasmolytic, vasodilatant and analgesic effects of carboxytherapy [2-8].

Clinical Features

In case of targeted medicinal administration of CO_2 – carboxytherapy – the gas increases the releasing of oxygen from haemoglobin and a pH of 6.8 and above increases the permeability of capillary walls [9,10]. A pH of 6.5 and above increases the flexibility and decreases the rigidity of collagen fibres [11].

Figure (3): Male patient with alopecia areata before carboxytherapy

Figure (4): The same patient after 20 carboxytherapy sessions

Regulations and requirements related to CO_2 gas administration in medicine are very strict, medicinal CO_2 gas is only supplied by licensed companies. The devices used in carboxytherapy are multiple variants, ranging from the so called "pens" to sophisticated devices featuring displays with detailed information. Modern technique safeguards patient safety in the first place, as well as performance, whereby devices nowadays

monitor the amount, pressure, time, the total volume and the temperature of gas administered in one session. The technique used to administer CO_2 abides by certain rules. There are two types of administration. Continuous administration is a technique of gradual administration of a predefined amount of CO_2 in certain localities (intradermal administration), under the skin (subdermal administration) and into deeper structures (subcutis, fatty tissue [12-14], muscles in physiotherapy and neurology [15], fibrous tissue in keloid scars [11,16] or in Morbus Peyronie [17, etc.]. Bolus administration of CO_2 is the administration of certain predefined bolus doses of CO_2 into predefined localities [18,19,7].

Intradermal and intracutaneous administration of CO_2 gas - This type of superficial administration results in visible lifting of the tissue, especially when targeted at skin imperfections and uneven appearance. The needle is inserted at the angle of 15˚ to 30˚.

Subcutaneous (subdermal) administration of CO_2 gas - The administration is deeper; the angle of the needle is 45˚

Note: Some procedures combine various administration techniques (such as intradermal "popcorn" technique and subcutaneous administration). Intramuscular administrations of CO_2 gas- Intramuscular CO_2 gas injections are given perpendicular to the skin at the angle of the needle of 90˚.

Figure (5): Female patient with ulcera cruris before carboxytherapy

Figure (6): The same patient- the final effect - 14 applications, the patient for 4 years has no relapses

Injection administration of CO_2 gas in acupuncture points – pneumopuncture. The administration of minimum doses (max. 5 ml/minute) of medicinal CO_2 to acupuncture points may potentiate the effect of acupuncture by stimulating certain (hyperalgic) points on the skin. Indications

for carboxytherapy in aesthetic dermatology - Rejuvenation of the face, neck, lower neck, and hand dorsae (fine and deeper wrinkles), reduction of dark circles under the eyes, fat deposits, sagging skin on the arms, cellulite, residual fat deposits after lipolysis (lower extremities, abdomen), contouring of lower abdomen [20], knees and ankles [21], treatment of stretch marks, atrophic scars, and minor keloids [12,13,20]. Indications in dermatology- alopecia (alopecia areata), small localised psoriatic foci, morphaea, keloid and burn scars, stretch marks, lichen ruber planus and hypertrophicus, wound healing in chronic venous insufficiency with lower leg ulcerations [22-28], diabetic wounds (accelerated healing). Carboxytherapy is currently being used with success in many branches of medicine, including: orthopaedic medicine and physiotherapy to manage pain, condition after traumas, arthritis, acute and chronic back pain and pain in other areas (due to the hypoalgic effect of medicinal CO_2), neurology, gynaecology, urology to manage erectile dysfunction associated with microangiopathy, rheumatology to reduce painful muscle irritation and others [28-30].

Figure (7): Lichen verrucosus- **Compare the first application and after the seventh application**

Figure (8): The same patient – after 7 applications

Pathological Manifestations

Any undesired effects of injection administration of CO_2 gas depend on the sensitivity of the individual patient, but the treatment is usually carried out without local anaesthesia. In general, carboxytherapy has minimum undesired effects. Undesired effects during the treatment session- the injection pain (due to nociception) is minimal, controlled, and resolves within a few seconds. A crackling sensation, stinging or burning sensation, and itching, these sensations also

resolve within a couple of minutes. Slight skin tension (when CO_2 penetrates into the tissue) and oedema may occur, however, these also resolve within a few seconds. Undesired effects after the treatment session- Immediately after the treatment patients report the sensation of heat, tingling, and sometimes burning (probably due to the influence of CO_2 on the depolarisation of nerve membranes). Such sensations usually resolve very soon. Prolonged heat sensation due to vasodilatation resolves within 10 to 20 minutes. Only in sensitive persons the given sensations persist up to 24 hours after the treatment session. If a vessel is hit accidentally, minor hematoma may occur. Ecchymosis, a subcutaneous spot of bleeding, is reported in 5% cases. Exceptionally, in case of administration in the per orbital area oedema may persist for more than 48 hours.

Prognosis and Treatment

Planning the frequency and number of treatment sessions- there are basic rules and recommendations related to the number and frequency of treatment sessions, but every patient needs an individual approach depending on the treated locality and their requirements, usually 5-20 treatment, sometimes more. The effects are usually observable after 3 to 6 treatment sessions. The skin looks healthier, minor wrinkles disappear, and the quality of skin improves. The skin is smoother and has a healthier glow. In general, the skin looks firmer after 8 to 10 treatment sessions. At the end of the therapy course the skin is tight, elastic, without excessive fat or wrinkles. The results will last depending on the lifestyle of the patient. In patients with a healthy lifestyle who drink enough water, refrain from smoking and only drink moderate amounts of alcohol, eat healthy and exercise the results will lasts for several months to years.

Combining carboxytherapy and other methods in aesthetic dermatology. It is up to the physician applying carboxytherapy to inform the patient of any combination possibilities and determine the therapeutic plan. It is necessary to define which treatment modality is of major importance and which treatments will only support the determined therapeutic plan to potentiate the final result. The physician is obliged (in order to achieve a good final result with a combination of techniques) to know the mechanism of action of each treatment modality and optimise the timing of the selected combination.

Note: In aesthetic dermatology the device is set so as to take into consideration the sensitivity of the individual patient- regulating the flow of CO_2. Recommended length of needles used in carboxytherapy- 30G mesotherapy needles. The selected length depends on the erudition of the physician. The needle should be replaced

after 8 to 10 injections.

General contraindications of carboxytherapy- include severe ischemic heart disease, acute embolism, thrombophlebitis and phlebothrombosis, gangrene, renal failure, untreated high pressure, stroke, pregnancy, lactation, severe adiposity with a BMI above 25 (body contouring), acute infectious disease, fever, excessive blood clotting, usage of anti-coagulants, hysteria, or fear of needles. Other contraindications also include high expectations and high biological age of the patient.

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