43 Solid Carbon Dioxide: Usage in Slush or Block Form as Therapeutic Agent in Dermatology

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Abstract

The use of solid carbon dioxide (CO_2) in dermatology is valuable to treat acne vulgaris, acne excoriee and as an adjunct in chemical peeling for the treatment of photo-aging and depressed scarring. This cryosurgical option is a cost-effective, viable treatment in the twenty-first century in the face of a flood of expensive devices for contemporary consideration. At −78 °C, a block of solid dry ice can be slushed in acetone and alcohol to efface comedones and promote more even healing of excoriated lesions. In addition, the combination of solid carbon dioxide followed immediately by trichloroacetic acid as a medium depth chemical peel has a place in the armamentarium of treatment in a series of over 4000 cases with a wide margin of safety in lighter skin types.

Keywords

CO_2 • Solid carbon dioxide • CO_2 slush • Cryosurgery • Cryotherapy • Chemical peeling • Neurotic excoriations • Acne vulgaris • Acne excoriee

Solid Carbon Dioxide

Solid CO_2 (dry ice) is a physical modality used in dermatology for the treatment of acne vulgaris, acne scarring, freckling and other cutaneous disorders for almost a century. Its properties and solid block temperature of −78.5 °C allow it to be used alone or to amplify chemical peeling.

CO_2 snow is prepared traditionally either by releasing the gas from a cylinder through a chamois leather bag and then transferring it to wood or Bakelite-funneled tubes in which the snow is hammered hard or by means of a "Sparkle" machine in which individual cylinders discharge the gas through a small opening into a collecting tube [1]. Pusey in 1907 introduced the use of solidified CO_2 whittled to appropriate shape and held onto a lesion from 2 s to as long as 60 s for destruction of skin lesions such as hemangiomas,

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Fig. 43.1 Storage of solid CO_2 in ice chest after twice weekly delivery and breaking for application to the skin

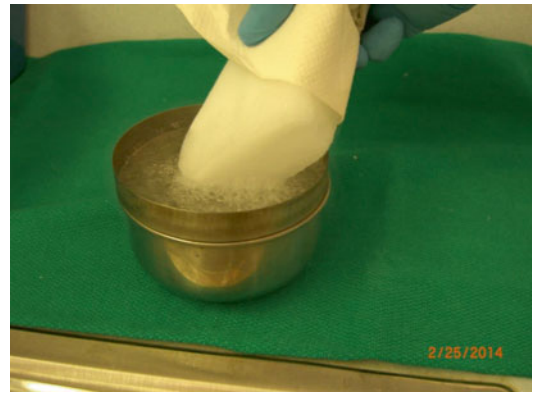

Fig. 43.2 Dipping of solid CO_2 into a 3:1 ratio of acetone to isopropyl alcohol solution for antiseptic slippage across the skin

prior to the development of LN. Dry ice is more easily obtained in the twenty-first century and may be found in grocery stores in large cities. It may be purchased from ice plants, ice cream manufacturers, dairies, food-packing plants, fishing bait supply houses, and pharmaceutical supply companies in smaller towns. Solid blocks can be delivered to offices twice weekly and stored in standard ice chests or coolers (Fig. 43.1). Five- or 10-lb blocks of ice are broken to hand size for slushing in acetone, ethyl acetate, or precipitated sulfur with or without alcohol before application to the skin in the treatment of acne [2–4]. Alternatively, the ice can be pulverized using a mortar to make a slush similar to a paste with the appropriate slushing agent selected and dabbed over the skin. Acetone serves to dissolve sebum and lowers the temperature of the CO_2 by accelerating the change of CO_2 from a solid to a gas [5]. If the snow is released from a cylinder of gas in the physician's office, hand packing to a hard solid form may be difficult and therefore less effective for a solid destruction mode as opposed to slush for acne treatment. Ideally, a block of solid CO_2 is broken to hand size, wrapped in a small hand towel and continually dipped in a 3:1 solution of acetone and alcohol so that the dry ice will move freely over the skin and kill surface bacteria [6] (Fig. 43.2).

Either an individual lesion or the entire face may be easily slushed using slow, even strokes; varying epidermal depths of cool will be produced

Fig. 43.3 Moving CO_2 across the skin for 6 s with illumination of comedones

by the pressure of application. Five to 8 s of moderate pressure per acne area is adequate to freeze comedones (Fig. 43.3). Solid CO_2 applied to the skin for 15 s produces complete epidermal necrosis with pronounced dermal edema. A mixed inflammatory infiltrate is seen without collagen destruction (Fig. 43.4). Varying pressure is applied to the skin by the ice block to induce microepidermal vesiculobullous formation where desired (Figs. 43.5 and 43.6). Pressure by the operator determines depth, and this may be noted on a diagram of the areas being treated in the patient's record. Mild pressure is 3–5 s, moderate pressure is 5–8 s, and hard pressure is 8–15 s (Table 43.1).

The seconds given are general guidelines, and the actual time and pressure will vary slightly

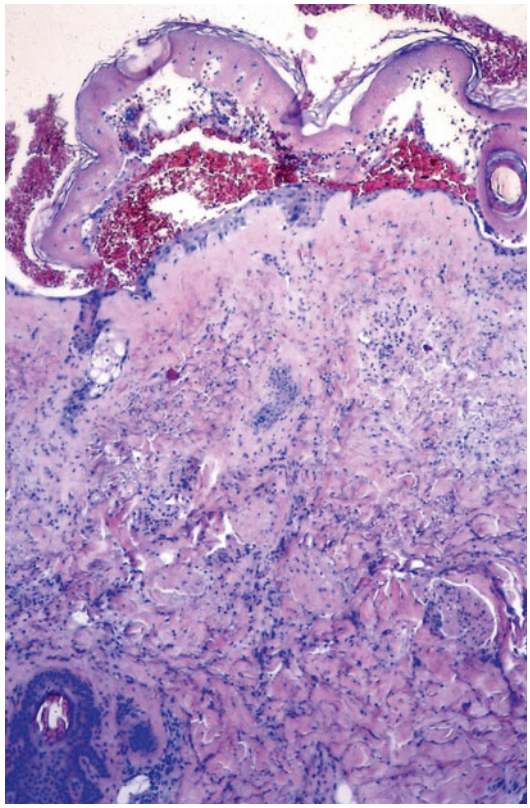

Fig. 43.4 Histology of solid CO_2 applied to the skin for 15 s, after 2 days producing epidermal necrosis with pronounced dermal edema, a mixed inflammatory infiltrate and no collagen destruction. After reepithelialization, neither collagen nor elastic fibers in the dermis show any architectural changes, confirming epidermal injury only (Hematoxylin-eosin [H & E] stain) (no elastic stain shown here)

Fig. 43.5 Epidermal vesicular formation, 8 h later

Fig. 43.6 Scaling and erythema with resolution of comedones, 6 days later

Table 43.1 Solid CO_2 administration

CO_2 pressure	Time (s)	Skin reaction
Mild	3–5	Erythema
Moderate	5–8	Erythema, edema and peeling
Hard	8–15	Vesiculobullous reaction

with patient tolerance and the dermatologist. The skin reaction ranges from mild erythema to vesiculobullae formation. All areas of the face may be iced to treat acne and mild photo-pigmentation, with defect size and patient tolerance being the chief limiting factors. The cheeks are less sensitive, and the glabella is more sensitive. Insertion of gauze into the mouth between the lips facilitates hard freezing over the upper lip onto the vermilion. The crow's feet and lower periorbital area may be frozen hard without difficulty. Care should always be taken to apply less pressure when freezing over bony prominences where post-inflammatory pigmentary changes may be more likely. Individual scars may be blunted with hard pressure. An electric fan or assistant's manual fanning to blow away the acetone vapors can facilitate patient breathing and reduce discomfort when freezing around the nose, mouth, and glabella (Fig. 43.7).

The dry ice is dipped into the solution multiple times during the treatment to allow easy slippage for skin application. This treatment speeds removal of comedones and promotes acne resolution. Patients may ask to be "iced" and enjoy the results of this treatment alone. Less destructive

Fig. 43.7 Freezing of upper lip with gauze in mouth to absorb any dripping and fan on patient to ease breathing from acetone and alcohol application

Fig. 43.8 Focused application of CO_2 to treat acne excoriee for 7 s

than liquid nitrogen, which is over twice as cold at −186 °C, the margin of safety of solid CO_2 is wide. It may induce transient hyperpigmentation in darker skinned individuals, but hard pressure and freezing the skin solid for 12–15 s has not produced scarring or hypopigmentation in non-poikilodermatous skin Fitzpatrick I–III type skin in our experience of over 4000 cases.

Solid CO_2 was used in the BioMedic Micropeel™, a proprietary peel system now owned by SkinCeuticals™. Shaving of the skin is followed by the application of 15–30 % glycolic acid and then by application of selective solid CO_2 slush. The now unnamed system is accompanied by and marketed with an extensive product line [7]. No clinical or histologic comparisons to other existing superficial peeling agents are available. One case of scarring has occurred allegedly from a Baker's phenol peel performed 3 days after this combination was applied to the face, indicating that the patient had sustained substantial epidermal alteration with the initial peel, allowing deeper penetration with the phenol formula.

Solid CO_2 slush is a superlative agent for facial and non-facial neurotic excoriations or acne excoriee. A moderate application to excoriated areas will serve to keep the patient's hands off the lesions long enough to heal and provide inspiration for the patient not to touch the areas for a variable length of time (Fig. 43.8). The result obtained using chemical peeling agents to excoriated areas is unpredictable in a patient with a tendency to pick and prematurely remove exfoliating skin. In our experience, the use of a physical agent such as solid CO_2 is less risky in this population than chemical wounding agents and is almost always effective and helpful.

Use of Solid CO_2 as a Preliminary Agent in a Medium Depth Chemical Peel

Traditionally, the classic peel for a medium depth peel to correct photodamage in the form of actinic keratosis, fine wrinkling, hyperpigmentation or depressed acne scarring was the 50 % trichloroacetic acid (TCA) peel, used extensively for decades as the classic peel for the patient who did not warrant, tolerate, or desire a "phenol peel."

Trichloroacetic acid, however, is an agent prone to produce increased scarring with higher concentrations. The need for an intermediate procedure that would achieve a similar depth but still not approach the toxicity of the phenol formulas was the impetus for the development of the procedure performed initially in 1980 by Brody and Hailey [8–10]. Insulting the epidermis with a refrigerant allows a less potent concentration of TCA such as 35 % to penetrate to the depth of a higher-strength 50 % solution. Although the temperature of the ice block of CO_2 is −78.5 °C, the skin temperature is considerably higher, as demonstrated by clinical experience and rapid thaw time. LN when used alone to treat scarring is approximately 100 °C colder than solid CO_2 and can achieve dermal

depth destruction and induce melanocyte toxicity, hypopigmentation, and scarring with improper technique [11]. CO_2 alone, however, does not usually induce scarring or hypopigmentation in lighter skin types and therefore has a wider margin of safety when combined with TCA for peeling. Over 4000 combination peels using CO_2 followed by 35 % TCA, both applied to the full face, confirm its effectiveness for photodamage and selected scars. The combination of two superficial agents to reach the depth of one single agent to increase safety is the rationale of all medium-depth peeling. CO_2 plus TCA has the greatest wound depth and histologic correction of elastotic changes with the widest papillary dermal Grenz zone after peeling of any published medium depth peel combination. Jessner's solution followed by TCA and glycolic acid followed by TCA are slightly less deep in penetration [12].

When freezing an individual depressed scar, it is permissible to freeze the rims for 10–15 s to afford greatest TCA penetration so that the scar edges will be clinically blunted. Immediately after freezing a deep scar, the skin may be wiped dry of flammable acetone, and the rim may be electrodessicated with monopolar current for further effacement. This is painless because of attendant CO_2 cryo-anesthesia. TCA can be applied after CO_2 to treat individual scar rims, solitary rhytides or keratoses, or areas at the vermilion border, for example. If freezing hard is absolutely necessary on the forehead, a nerve block may be helpful. Facial freezing with CO_2 makes immediate application of TCA more tolerable. The burning sensation that accompanies the application of the TCA is lessened by the CO_2 slush applied immediately before and can be minimized further by the immediate application of an ice pack or cold gel pack (3M) after adequate frosting has occurred. After 5 min, a soothing emollient can be used.

Complications of Solid CO_2: Cold Sensitivity or Cold Urticaria

When using solid CO_2 (dry ice) to freeze the skin either alone or in combination with TCA in medium-depth peeling, transient swelling or urticaria can be produced in distant areas [13]. We have seen this in only one patient in a series of over 4000 CO_2 + TCA peel patients. Because CO_2 has minimum temperature of only −78.5 °C and because it is rarely concentrated in any one area for more than 20 s, it is limited in its ability to produce cold reactions. The freons, LN, and prolonged cold immersion with ice water are more common precipitating factors [14]. The application of a 10-s LN spray to the entire face for acne scar treatment has resulted in full-thickness necrosis and scarring as a result of the presence of occult cryofibrinogenemia [15]. Increased serum levels of cryofibrinogens are found in about 4 % of apparently normal individuals and may signal collagen-vascular disease, malignancy, pregnancy, oral contraceptive use, excessive smoking, or thromboembolic phenomena. Cryofibrinogenemia may be a transitory condition. This necrosis has not been reported with solid CO_2. Transient stinging and burning sensations may occur during any freeze phase, and treatment to the forehead, especially if prolonged, may produce a headache that may persist for several hours. This responds to acetaminophen or ibuprofen.

There is limited evidence published in peer-reviewed medical literature that addresses the efficacy of comedo removal for the treatment of acne, despite its long-standing clinical use. However, it is the opinion of the Guidelines of Care Work Group of the American Academy of Dermatology that comedo removal may be helpful to the management of comedones resistant to other therapies [16]. While it cannot affect the clinical causes of the disease, it can improve the patient's appearance, which may positively impact compliance with the treatment program.

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