

Carbon Dioxide Laser in Dermatology

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The carbon dioxide (Co₂) laser has been used in Dermatology for more than 20 years (Fig. 1). Co₂ laser produces a light source that emits light, although not visible, in a continuous wave at 10600 nm in the far infrared spectrum of the electromagnetic spectrum⁽¹⁾. Co₂ laser light is strongly absorbed by water which is the major component of all soft tissue including the skin. Tissue injury is produced when Co₂ laser light is absorbed by water in the tissue releasing heat that irreversibly damages tissue proteins. Ninety percent of Co₂ laser radiation energy is dissipated using a 0.2-s pulse and a 1-mm spot size within 0.1 mm of tissue. In general, the advantages of the Co₂ laser include the ability to produce limited destruction very rapidly, with relative hemostasis during the procedure and minimal postoperative edema or pain.

Technique

The Co₂ laser can be used for controlled excision, vaporization and coagulation of epidermal and dermal lesions⁽¹⁾. Thermal damage of adjacent tissue varies directly in relationship to duration of exposure. Heat diffusion from the treated site causes a zone of coagulative necrosis up to 0.6 mm away from the target. The thermal coagulation zone allows for relatively bloodless excision as vessels, up to 0.5 mm in diameter, are thermally coagulated. The beam of the laser can be focused to a small spot size with great power density leading to incision of tissue. As the laser beam is defocused with resulting lower density power, vaporization of tissue is achieved. Further reduction of power density, which

may be obtained by defocusing the beam, causes thermal coagulation of tissue that may be useful for hemostasis.

For a laser with 75-mm focusing lens, at a spot size of 0.2 mm with the power output set at 20 W, the power density is 64000 W/cm² at the skin surface. Alternatively, the beam may be defocused with a larger spot size. For a similar laser, a 2-mm spot size and a power output of 20 W, the power density at the skin surface is 637 W/cm². Power density and spot size may be varied almost indefinitely by moving the hand piece toward or away from the tissue by changing the power output. The Co₂ laser beam can be administered as single pulses or as a continuous beam, usually using a power output of 5-20 W. The draw backs of this technique include dependence on the accuracy of the surgeon to judge the depth of the lesion, and the lack of precise calculation of power densities and duration of exposure for each treatment. Because the endpoint of Co₂ laser treatment is eradication of the lesion, the optimal power density is that which is enough to achieve vaporization of the complete lesion.



Fig. 1: The Co₂ laser coupled to a colposcope.

Indications

In our experience, Co₂ laser is most useful for vaporization of superficial cutaneous lesions. A wide variety of skin disorders limited to the epidermis and dermis can be effectively vaporized using the Co₂ laser.

1 - Warts

One of the most common indications for Co₂ laser treatment is recalcitrant genital warts (condyloma

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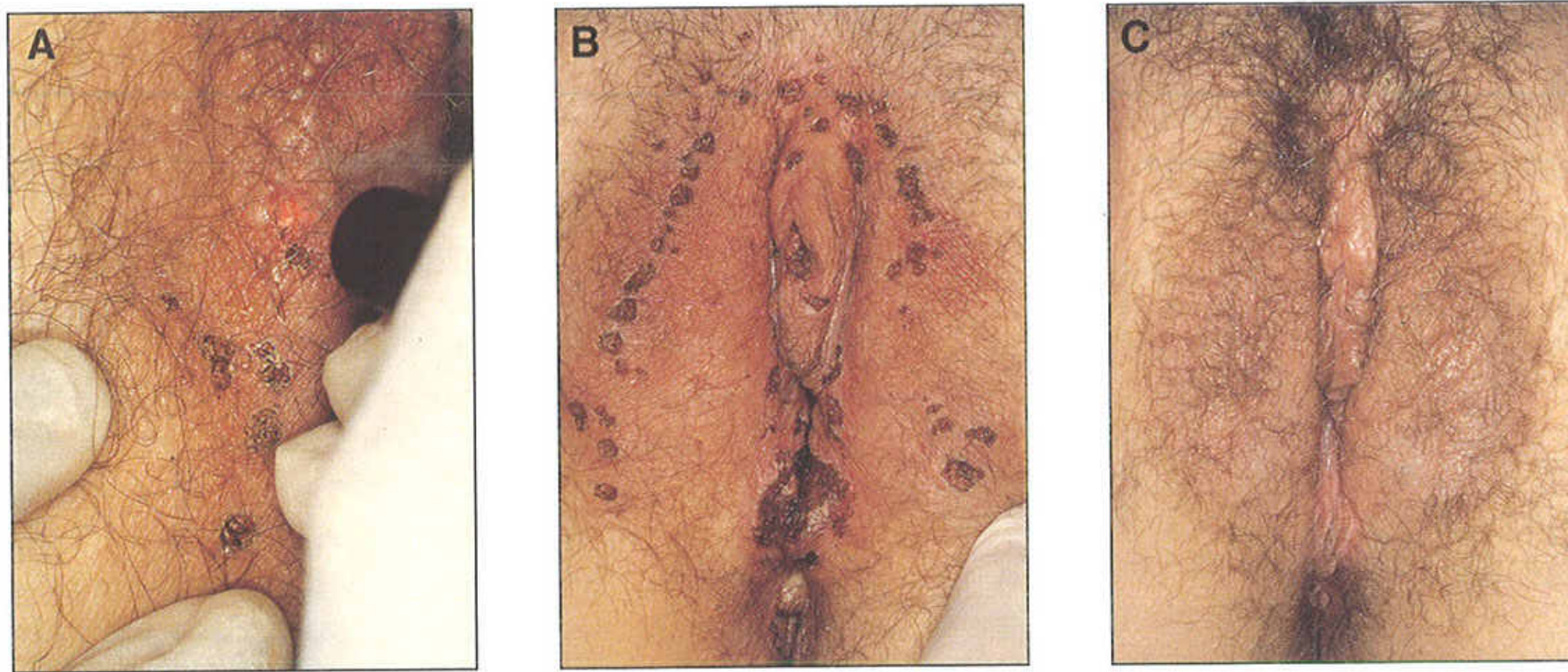


Fig. 2: Co2 laser vaporization of genital warts (A). Female external genitalia postoperative (B) and at control visit 8 weeks later (C).

acuminatum). Even extensive disseminated genital lesions, including peri- or intra-anal, vaginal and urethral located lesions, can be treated successfully⁽²⁾. In the majority of patients the procedure can be performed with local anesthesia resulting in high cure rates (Fig. 2). Subclinical foci of human papillomavirus (HPV) infection in surrounding tissue is a common cause of recurrence after laser therapy. However, repeated Co2 laser treatment is often effective except in immunosuppressed patients⁽²⁾. Co2 laser may not be more effective than standard surgical modalities, but it is certainly less cumbersome to treat multiple genital warts with Co2 laser as opposed to electrodesiccation or conventional surgery⁽³⁾. In addition, colposcopic magnification during the Co2 procedure may help to visualize smaller lesions (Fig. 1).

Another important indication is resistant verruca vulgaris including periungual lesions and verruca plantaris⁽⁴⁾. Cure rates of 80 - 90% are achieved for difficult plantar and periungual warts in which previous treatment has failed. Also, hypertrophic verruca vulgaris with unusual localization may be treated effectively with the Co2-laser (Fig. 3)⁽⁵⁾.

2 - Premalignant lesions

HPV-associated neoplastic genital disorders, such as bowenoid papulosis, erythroplasia of Queyratt, and lesions representing vulval, penile, or anal intraepithelial neoplasia- including squamous cell carcinoma in situ- can often be treated successfully with the Co2 laser^(6,7). Giant condyloma and

verrucous carcinoma can often be treated with Co2 laser.

Another dysplastic lesion where Co2 laser is the treatment of choice is actinic cheilitis. The atypical epidermal cells confined to the squamatizing mucosa of the lower lip can be vaporized rapidly after local anesthesia. Alternative therapies such as cryosurgery, electrodesiccation, excision, and topical 5-fluoro-uracil application cause greater morbidity and are associated with lower rate of success. Multiple actinic keratoses in immunosuppressed organ transplanted patients, often resistant to treatment, can be effectively removed by Co2 laser.

3 - Benign cutaneous lesions

A variety of epidermal and dermal lesions can be treated with the Co2 laser including rhinophyma⁽⁸⁾, syringoma, trichoepithelioma, neurofibroma, myxoid cyst, porokeratosis⁽⁹⁾, lichen myxedematosus⁽¹⁰⁾, apocrine hydrocystoma⁽¹¹⁾, verrucous epidermal nevi⁽¹²⁾, adenoma sebaceum, subungual fibroma⁽¹³⁾, and acne keloidalis nuchae⁽¹⁴⁾.

4 - Vascular lesions

The use of the Co2 laser should be restricted to very few pathologic disorders which include venous lake, selected cases of hypertrophic port wine stains and pyogenic granuloma.

5 - Inflammatory lesions

Hidrosadenitis⁽¹⁵⁾, granuloma faciale⁽¹⁶⁾, suppurating hidrosadenitis⁽¹⁷⁾ and perifolliculitis capitis⁽¹⁸⁾ are

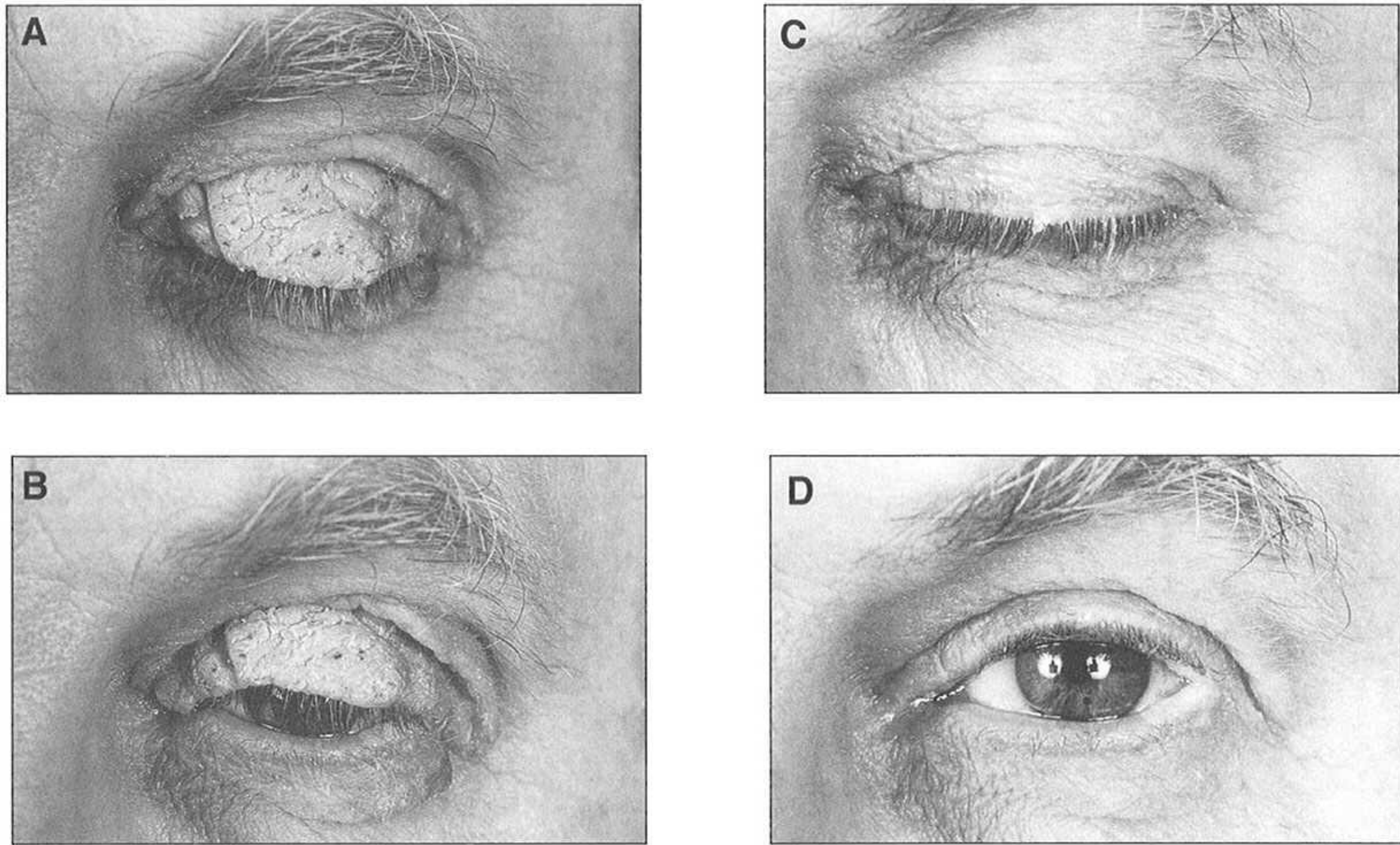


Fig. 3: A hyperkeratotic verruca vulgaris on the upper eyelid before (A-B) and after (C-D) Co2 laser treatment.

inflammatory conditions that may respond favorably to Co2 laser treatment.

6-Other cutaneous lesions

Acantholytic diseases such as benign familial pemphigus (Hailey-Hailey disease) and localized Darier's disease^(19,20) may respond to Co2 laser vaporization.

Safety

Adverse reactions of Co2 laser are rarely seen. Hypertrophic scarring is reported in approximately 1 to 4% of treated patients depending on the indications⁽¹⁾. Secondary bacterial infections is seldom seen if proper wound care include washing with mild soap followed by applications of an antibacterial ointment. Complete healing can require 2 to 8 weeks depending on the size of the wound and the extent of the surgery.

Use of the Co2 laser is accompanied by potential noxious smoke. The laser plume contains particles with a diameter in the range 0.1 - 1 microns known to penetrate the deepest part of the lung tissue. Viable HPV has been demonstrated in the plume after Co2 laser treatment of warts⁽²¹⁾, and it has recently

been shown that laser surgeons have an increased risk of contracting orolaryngeal warts⁽²²⁾. In contrast to HPV, viable HIV has not been found in the plume but can be cultured from the dermabrasion mist⁽²³⁾. Standard precautions to prevent the spread of potential infections material in the plume include gloves, face mask, goggles, and smoke evacuator.

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