Lasers in Dermatology—1983

Lasers (light amplification stimulated emission of radiation) produce a high intensity light that can be applied to tissues for diagnostic or therapeutic purposes. When the laser tube containing a solid or gas medium is energized, the excited electrons of this medium fall back into resting configuration, and a characteristic energy is produced as light within the tube. The light bounces back and forth, stimulating other atoms or molecules in a self-magnifying effect. The light can then be released from the tube and applied to tissues. This light has three characteristics. It is monochromatic (of a single wavelength). It is coherent (spatially and temporally in phase). It is highly collimated (it travels in nondivergent parallel beams). Because of these combined characteristics, lasers exert a tremendous amount of energy, which can be brought to bear on a skin target.

Carbon dioxide (CO_2) and argon lasers are the two most commonly used in dermatology. The CO_2 laser produces light of 10,600 nm (the far infrared portion of the electromagnetic spectrum). This light output is delivered through a system of closed tubes with mirrored joints to a surgical handpiece rather than through a fiberoptic system. The argon laser produces light in the blue-green portion of the visible spectrum at two wavelength peaks, 488 and 514 nm. This light can be effectively transmitted through fiberoptic cables.

These systems differ greatly from each other in several ways in their interaction with the skin. The CO_2 laser beam is totally absorbed at a depth of only 0.1 mm of water or tissue. Scatter within the tissue is minimal. In contrast, the argon laser beam penetrates a column of tissue approximately 1 or 2 mm with considerable scatter. The argon beam exhibits selective absorption, being highly absorbed by tissues of its complementary color (red). Since the CO_2 beam is infrared, it exhibits no selective color absorption characteristics.

Thus, CO_2 laser beam effect is extremely focal and localized, instantaneously vaporizing tissue at 100°C with virtually no thermal conduction or effect to surrounding tissue. However, effects of the argon laser on tissue are much less focal and localized because of greater penetration and scatter with considerably more thermal conduction to adjacent tissues. Thus, the argon beam produces a more zonal field of destruction.

The CO_2 laser system is extremely versatile. If the beam is focused on the tissue surface, the impact spot is only 0.1–0.2 mm. The power density range is 50,000–100,000 watts/cm^2. The laser beam, acting as a scalpel, incises tissue. If the beam is defocused on the tissue surface, the impact spot increases to 2 mm with a power density of approximately 500–1000 watts/cm^2. The beam vaporizes the surface rather than incising it. Thus, the CO_2 laser can be used for incisional or excisional procedures as well as for vaporization.

The CO_2 laser offers many advantages in both modes. The beam sterilizes the field as it cuts and is highly hemostatic. Lymphatic channels are sealed. Small nerve endings are sealed over, with minimal postoperative pain. The laser preserves adjacent tissue architecture and does not produce thermal necrosis that would interfere with histologic examination.

The CO_2 laser has been used for many types of dermatologic procedures including removal of tattoos[1]; treatment of skin cancer, either by excision or by the Mohs surgical technique[2]; treatment of plantar warts and condyloma acuminata; excision of keloids; removal of lymphangioma circumscriptum; and removal of miscellaneous lesions including epidermal nevi, cherry angiomata, and pyogenic granuloma. Furthermore, the CO_2 laser is effective in removal of port-wine stains.[3–5]

Tattoos are treated with the CO_2 laser in the defocused mode. The skin is vaporized in a series of overlapping craters with a power density of 500–1000 watts/cm^2 at short pulse durations. Vaporization is done sequentially under magni-

fied vision until all tattoo pigment has been removed. The wound, allowed to granulate for several weeks, heals with an acceptable supple scar of good color. Hypertrophic scarring is minimal. The procedure is completed in one stage with total pigment removal and complete visual control. There is no bleeding. Adjacent tissues are preserved and healthy, and postoperative pain is minimal.

Skin cancers can be excised with the CO_2 laser. Primary excision is performed with the laser in a focused mode. Depth of cut and amount of hemostasis are inversely proportional to the cutting speed. The cut is precise, sterile, and bloodless. Adjacent tissues may be undermined to create flaps without the risk of hematoma. Healing is rapid and excellent with primary closure.

Complicated tumors can be removed by the Mohs histographic technique with the CO_2 laser used as a scalpel. The operative field remains dry and the tissue architecture is preserved. Healing by granulation is excellent. The CO_2 laser beam can cut thin layers of bone for histopathologic examination, if necessary.

The CO_2 laser is particularly effective for treating recurrent warts, plantar warts, and condyloma acuminata. The wart tissue is vaporized under magnified vision in a bloodless procedure without damage to surrounding areas. Healing occurs rapidly with minimal discomfort. Surgery can be extended into the urethral meatus, the vagina, and the anal canal.

Lymphangioma circumscriptum may be treated superficially with the CO_2 laser. Papules and nodules are vaporized at a low power density. Feeding lymphatics are sealed off, and healing is rapid and excellent without recurrence.

Keloids of the earlobes, extremities, and trunk are treated with the CO_2 laser in the excisional focused mode. A shave excision is performed without bleeding and without damage to surrounding connective tissues. When the entire keloid has been excised, the base is injected with intralesional steroid suspension. No sutures are placed and the wound heals by granulation. Healing has been extremely satisfactory without recurrence of keloidal tissue.

The argon laser has been favored by most investigators in the treatment of port-wine stains. Treatment relies on the theoretical selective absorption of blue-green laser light by the red pigment present in red blood cells. The surrounding dermal stroma would be relatively spared, theoretically, whereas the blood vessels are selectively destroyed. Results have been good. Problems include failure of the lesions to lighten in some cases, particularly on the trunk and extremities; and the formation of unacceptable scars, most commonly on the extremities and upper lip area. A test area should be treated for evaluation purposes before complete treatment is undertaken. The test area should be evaluated at four months postoperatively before further treatment is begun. Initial whitening of tissue is noted, followed by blister and crust formation. Healing occurs in three to four months with gradual progressive lightening of the angioma.

The CO_2 laser can also be helpful in treating port-wine stains. This method does not rely on selective color absorption, but depends upon vaporization of the surface tissue overlying the angioma with resultant constriction of the vessels below to produce an improved cosmetic result. The technique is performed much as for tattoo removal with the laser in a defocused mode at low power densities. A test site is treated initially, and, if results are good, further treatment is undertaken.

Certain criteria are helpful in selecting patients for either argon or CO_2 laser therapy of port-wine stains. If the lesion is pale to light pink, the CO_2 laser is favored, and if the lesion is dark blue-purple, the argon laser is favored. If the lesion is flat and nonindurated, the CO_2 laser is preferred, whereas boggy, indurated, and nodular lesions require the argon laser. If the lesion blanches on pressure, the CO_2 laser is favored; lesions that do not blanch require the argon laser. Biopsy of the port-wine stain revealing few vessels and a low blood cell mass requires CO_2 laser therapy, whereas lesions having ectatic vessels with a high red cell mass respond more favorably to argon laser therapy. If no definite distinctive preoperative criteria are apparent, test sites should be treated with both systems and the results evaluated at four months, before definitive therapy is undertaken.

Laser therapy in dermatology appears exceptionally promising. Many medical centers are establishing clinical laser units, and the shared experiences of clinical investigators are leading to new effective therapies for previously untreatable conditions. Furthermore, much basic research is underway in laser technology and laser-tissue biologic interactions. New lasers are being developed, and present systems are being reduced in

size and cost. The tunable dye laser with its adjustable wavelength range may soon move from the optical bench to the clinical setting where the operator will be able to select the optimal laser beam for the target tissue. Likewise, new units combining several types of lasers in a single handpiece are arriving from Japan.

Thus, it seems unlikely that the laser will be consigned to the role of an esoteric plaything. More likely, it will become a valuable and unique dermatologic therapeutic tool.

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Androgens and the Pilosebaceous Follicle in Women: Technology Catches Up with the Clinician

In this issue of the *Quarterly*, Kasick et al (page 111) report the promising results of their investigation of 19 white women with female androgenic alopecia. Their data confirm what clinicians have long assumed. The mechanistic link between androgens and female androgenic alopecia, "idiopathic hirsutism," and acne vulgaris seems obvious; however, the link has been difficult to prove. Pioneering clinical studies in the early 1940s established the effect of testosterone on the pilosebaceous follicle and the androgen sensitivity of acne vulgaris.[1] Progress in defining the role of androgens lagged during the next three decades because the only readily available test for studying circulating androgens in women was the relatively imprecise assessment of metabolites of androgens in the urine by means of the urinary 17-kestosteroid test (17 KS). A technologic breakthrough occurred in the 1970s when radioimmunoassays permitted accurate direct measurements of circulating androgens.

Experience in the last decade with the direct measurement of serum steroids has delineated the ovarian and adrenal pathways of androgenic steroids. Catheterization studies of adrenal and ovarian veins show that approximately 25% of circulating testosterone is derived directly from the adrenal gland and 25% from the ovaries. Approximately 50% of circulating testosterone arises from peripheral conversion in the skin, liver, and fat of the prehormones, androstenediol (A) and dehydroepiandosterone (DHEA) and its sulfate (DHEAS). The adrenal cortex contributes 80% of the circulating DHEA and 90% of the DHEAS, making DHEAS a useful marker for adrenal androgen secretion.

The major portion of circulating sex hormones is bound to testosterone-estradiol binding globulin (TeBG). Extensive data suggest that bound steroids are inactive, and that only unbound free testosterone (free T) is biologically active. Levels of free T can be greatly increased while circulating total testosterone (total T) levels are normal or only mildly increased.

In hirsute women, free T levels are increased; however, more than 50% of the patients studied have normal total T levels.[3] The ovaries are the predominant source of androgen in these women.[4] No universal correlation between acne in women and elevated free T, total T, or DHEAS has been demonstrated.[5] It has been postulated that increased enzyme activity within sebaceous cells may amplify the effects of normal levels of circulating androgens, but the androgen connection in acne remains to be solved.

Studies have failed to show a universal correlation between free T and total T in women with androgenic alopecia. Kasick's study, demonstrating increased DHEAS levels in his patients, gives credence to the pivotal role of the adrenal glands in androgenic alopecia. Their data show increased serum prolactin levels in 2 patients. In this small subset of patients a pituitary adenoma appears to be the cause of the adrenal hyperfunction. The basic adrenal mechanism in the majority of their patients awaits further study.

The appropriate laboratory investigation of a premenopausal woman with androgenic alopecia should include determinations of serum DHEAS, serum prolactin, and serum total and free testosterone. The tests are readily available and sensitive. The results provide reliable information