Standard guidelines of care: CO_2 laser for removal of benign skin lesions and resurfacing

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ABSTRACT

Resurfacing is a treatment to remove acne and chicken pox scars, and changes in the skin due to ageing. **Machines**: Both ablative and nonablative lasers are available for use. CO_2 laser is the gold standard in ablative lasers. Detailed knowledge of the machines is essential. **Indications for CO_2 laser:** Therapeutic indications: Actinic and seborrheic keratosis, warts, moles, skin tags, epidermal and dermal nevi, vitiligo blister and punch grafting, rhinophyma, sebaceous hyperplasia, xanthelasma, syringomas, actinic cheilitis angiofibroma, scar treatment, keloid, skin cancer, neurofibroma and diffuse actinic keratoses. CO_2 laser is not recommended for the removal of tattoos. **Aesthetic indications:** Resurfacing for acne, chicken pox and surgical scars, periorbital and perioral wrinkles, photo ageing changes, facial resurfacing. **Physicians' qualifications:** Any qualified dermatologist (DVD or MD) may practice CO_2 laser. The dermatologist should possess postgraduate qualification in dermatology and should have had specific hands-on training in lasers either during postgraduation or later at a facility which routinely performs laser procedures under a competent dermatologist/plastic surgeon, who has experience and training in using lasers. For the use of CO_2 lasers for benign growths, a full day workshop is adequate. As parameters may vary in different machines, specific training with the available machine at either the manufacturer's facility or at another centre using the machine is recommended. **Facility:** CO_2 lasers can be used in the dermatologist's minor procedure room for the above indications. However, when used for full-face resurfacing, the hospital operation theatre or day care facility with immediate access to emergency medical care is essential. Smoke evacuator is mandatory. **Preoperative counseling and Informed consent** Detailed counseling with respect to the treatment, desired effects, possible postoperative complications, should be discussed with the patient. The patient should be provided brochures to study and also given adequate opportunity to seek information. Detailed consent forms need to be completed by the patients. Consent forms should include information on the machine used; possible postoperative course expected and postoperative complications. Preoperative photography should be carried out in all cases of resurfacing. **Choice of the machine and the parameters** depends on the site, type of lesion, result needed, and the physician's experience. **Anesthesia:** Localized lesions can be treated under eutectic mixture of local anesthesia (EMLA) cream anesthesia or local infiltration anesthesia. Full-face resurfacing can be performed under general anesthesia. Proper **postoperative care** is important to avoid complications.

Key Words: Ablative laser, Keratoses, Resurfacing, CO_2 laser

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INTRODUCTION

Over the past decade, advances in laser technology have allowed dermatologists to improve the appearance of scars and wrinkles and to remove benign skin growths using both ablative and nonablative lasers. Chemical peeling, dermabrasion, surgical scar revision, electrosurgical planning, and dermal/subdermal filler substances and lasers are some of the modalities used by dermatologists for the correction of scars and wrinkles. Lasers constitute an important modality for both aesthetic and therapeutic indications.

RATIONALE AND SCOPE

The field of lasers is rapidly evolving and new machines are being introduced every year. Much variation exists in different machines and techniques; therefore, establishing standard guidelines has limitations. The guidelines recommended here indicate minimum standards of care in the use of CO_2 laser.

BACKGROUND

Principle of ablative resurfacing: Presently, five laser modalities are available for ablative skin resurfacing:

- Scanned carbon dioxide laser
- Pulsed carbon dioxide laser
- Pulsed Er:YAG laser
- Fractional Er:YAG laser resurfacing
- Combination carbon dioxide and Er:YAG lasers

Each of these machines relies on the principles of selective photothermolysis in order to selectively target water-containing tissue and cause controlled tissue vaporization. Although devoid of colour, water is the chromophore, CO_2 laser treatment ensures minimal discomfort and rapid recovery, enabling a quick return to daily routine. The carbon dioxide laser emits an invisible infrared beam at 10,600 nm, targeting both intracellular and extracellular water. When light energy is absorbed by water-containing tissue, skin vaporization occurs. Recent advances in carbon dioxide laser technology have enabled machines to deliver sufficient energy to vaporize the skin in $<$ 1 millisecond. These include:

a) Use of an ultra-short pulse to deliver the energy to tissue
b) The use of a scanner minimizes dwell time in a unit volume of tissue; use of a computer-controlled opto-mechanical shutter system helps to scan a continuous wave beam so rapidly that the emitted light is prevented from coming into contact with the skin for $>$ 1 millisecond.

Factors contributing to the absence of uniform laser parameters in clinical practice

Uniform criteria for the use of CO_2 lasers are absent. Reasons for this are:

a) While several clinical and histological studies have been reported in the medical literature, varying styles of laser practice between surgeons could affect the clinical results. In addition to the laser parameters chosen, clinical effect is also influenced by the number of laser passes delivered, the degree of pulse or scan overlap, the complete/incomplete removal of partially desiccated tissue between each laser pass, preoperative preparation, and postoperative wound care.
b) The use of free hand lasing with a focusing hand piece renders CO_2 lasing operator-dependent and not amenable to precise guidelines on fluence. Hence, descriptions will perforce have to be in terms of spot size, mode, power, focusing, gating, overlap and passes.
c) The parameters described for scanner-based work and collimated hand pieces do no apply in freehand lasing with a CO_2 laser technique that utilizes a focusing hand piece. The bulk of CO_2 laser surgeries utilize focusing hand pieces with spot sizes of 0.1, 0.2 and 0.4 mm for cutting, coagulation and vaporization.

PHYSICIANS' QUALIFICATIONS

As with any dermatosurgical modality, the dermatosurgeon must have a complete understanding of the indications and limitations of a given procedure. The dermatosurgeon should possess postgraduate qualification in dermatology and specific hands-on training in lasers either during postgraduation or later at a facility that routinely performs laser procedures under a competent dermatologist/plastic surgeon with experience and training in using lasers. As parameters may vary in different machines, specific training is essential with the available machines at either the manufacturer's facility or at another centre using the machine. While minimal training is needed for CO_2 lasers for benign growths, which can be given in a day's workshop, resurfacing for the face needs more advanced training and can only be performed after adequate experience has been gained with the machine.

FACILITY

A CO_2 laser can be used in the dermatologist's minor procedure room for removal of benign growths and treating localized lesions. However, when used for full-face resurfacing, a hospital operation theatre or day care facility with immediate access to emergency medical care and standby anesthetist is essential. Smoke evacuator is mandatory.

INDICATIONS AND PATIENT SELECTION

Therapeutic indications

Actinic and seborrheic keratosis (level C),[1-5] warts (Level B),[6-9] moles, skin tags, epidermal and dermal nevi (level B),[10-15] xanthelasma (level C),[16-20] vitiligo blister and punch grafting.

Other conditions that have been shown to respond favorably to carbon dioxide laser resurfacing include rhinophyma (level C),[21-25] severe cutaneous photodamage (observed in Favre-Racouchot syndrome), sebaceous hyperplasia, syringomas (level B),[26-30] actinic cheilitis (level C),[31-35] angiofibroma (level C),[36-38] scar treatment (level C),[39-41] keloid (level C),[42-44] skin cancer (level C),[45-48] neurofibroma (level C) [49-51] and diffuse actinic keratoses. Carbon dioxide lasers were used in the past for tattoo removal (in conjunction with dermabrasion and salabrasion); however, their use for this purpose has been largely abandoned because of the availability of more tattoo-specific lasers.

Aesthetic indications

Periorbital and perioral wrinkles (level C),[52-54] facial resurfacing (level B) [55-59] and acne scars (level C).[60-64]

Skin resurfacing with a pulsed or scanned carbon dioxide laser is commonly used for improvement of fine or moderate rhytides. While deeper rhytides may also be improved, other procedures such as autologous fat transplantation, contour threadlifting, sculptra® injections, Gore-Tex/other implantation, or surgical lifting can be used to provide additional benefit. Dyschromias including solar lentigines,[65,66] are often improved with laser resurfacing, although they are not generally regarded as a primary indication The success of a cutaneous resurfacing procedure relies on the presence of skin appendages (*e.g.*, sweat glands, folliculo-infundibular units) to serve as sources of epithelium that can migrate upward to form the new epidermis. Therefore, the greater the number of skin appendages per square centimeter of skin, the more rapid the healing and the lower is the risk for scarring. For this reason, carbon dioxide laser resurfacing is largely limited to the face. Resurfacing of the hands and neck has been successful, although a much greater risk for scarring exists when treating these areas. Improvement of melasma has been reported, although the recurrence rate is high after laser resurfacing.

Carbon dioxide laser resurfacing may greatly improve atrophic scars caused by acne, trauma, or surgery. Deeper pitted acne scars often require ancillary procedures for optimal results, such as excision or punch grafting. These procedures can be performed either prior to or concomitant with carbon dioxide laser resurfacing.

Patient selection, counseling and informed consent

As with any cosmetic procedure, proper patient selection is essential.

- During the initial consultation, the surgeon should ascertain the patient's expectations of treatment and the circumstances leading to the decision to have cosmetic surgery.
- A complete medical and surgical history, including recent use of isotretinoin (its regular use within a year prior to dermabrasion has shown a higher risk of hypertrophic scarring) should be obtained.
- History of previous laser resurfacing, dermabrasion or deep phenol peel should be noted, because these procedures could potentially delay the wound healing response due to the presence of fibrosis. Patients with a prior history of transcutaneous lower blepharoplasty and limited infraorbital elasticity may have increased risk of ectropion. When applicable, patients should be discouraged from smoking before and after surgery to reduce the risk of delayed or impaired wound healing.
- Skin to be treated should be thoroughly examined-scarring, dyschromia, rhytid formation, and skin type should be noted carefully. For patients desiring periorbital laser treatment, the eyes should be carefully examined for scleral show, lid lag, and ectropion.
- Other cutaneous disorders should also be investigated, including seborrheic keratosis, solar lentigines, actinic keratosis, acne vulgaris, and cutaneous carcinomas. The latter should be treated prior to any resurfacing procedures.
- With this information, the benefits of laser resurfacing must be assessed along with its limitations and risks.

Most importantly, patients should have realistic expectations

and sound reasons for deciding to undergo the cosmetic laser surgical procedure. Other cosmetic treatment options should be reviewed too so that the patient may make an informed decision. The patient should understand that there is a postoperative healing phase with erythema and crusting that lasts for 1-2 weeks. The need to avoid sunlight during postoperative healing should be emphasized. It is worthwhile to include explicit instructions to the effect in the consent form (refer Appendix). In dark-skinned patients as seen in south India, pigmentation is a possible complication and this may last for several weeks; this fact should be emphasized in the counseling sessions. While CO_2 laser resurfacing is usually a one-time procedure, many patients may need repeat treatments and if the physician thinks that a second session may be needed, this information should be given to the patient.

Contraindications

Absolute contraindications include isotretinoin use within the previous six months, active cutaneous bacterial or viral infection in the area to be treated, and ectropion (for infraorbital resurfacing).

Relative contraindications include patient history of keloid formation or hypertrophic scarring, ongoing ultraviolet exposure, prior radiation therapy to treatment area, and collagen vascular disease.

Caution should be taken with patients who smoke or who have a history of previous laser resurfacing, phenol chemical peel, dermabrasion, and/or transcutaneous lower blepharoplasty. Also, patients planning to undergo neck or extremity laser resurfacing should be forewarned of the increased risk of fibrosis in these areas.

Pretreatment care

The following pretreatment guidelines are only applicable for resurfacing extensive areas:

- Topical retinoic acid, hydroquinone and broad spectrum sunscreen are required two to four weeks before surgery.
- Systemic antibiotics: Some surgeons routinely prescribe antibiotics for antibacterial prophylaxis; however, convincing data do not exist to support their use, given the relatively low incidence of postoperative bacterial infection. The choice of the antibiotic is as per patient's preference; cephalosporin (cephalexin), semisynthetic penicillin (dicloxacillin), macrolide (azithromycin) or quinolone (ciprofloxacin) is begun a day before or on the day of surgery and continued until re-epithelialization is complete. The use of topical antibiotics on the laser-induced wound is not routinely recommended because of the possibility of contact dermatitis.
- Antivirals: Acyclovir is indicated in patients with history of previous herpes simplex. As laser skin resurfacing can cause reactivation of latent herpes simplex infection or can predispose the patient to a primary infection during the re-epithelialization phase of healing, prophylactic use of an antiviral medication during the postoperative period is recommended, regardless of a patient's herpes simplex virus history. Acyclovir may be begun either 24 hour prior to surgery, or on the morning of surgery. Commonly used regimens include famciclovir 250 mg PO bid, acyclovir 400 mg PO tid, and valacyclovir 500 mg PO bid for 7-10 days.

ANESTHESIA

For small lesions, EMLA cream applied under occlusion for 30-60 minutes is adequate. For localized areas, local infiltration with 1% lidocaine and epinephrine is usually sufficient to produce adequate anesthesia. For larger areas, such as full-face resurfacing, nerve blocks (*e.g.*, supraorbital, supratrochlear, infraorbital, mental) may be needed along with local infiltration. Some surgeons use tumescent anesthesia with or without nerve blocks to provide local anesthesia, while others prefer to use conscious sedation (or twilight anesthesia) alone or in conjunction with other techniques.

Postoperative care and complications

Carbon dioxide laser resurfacing imparts a thermal injury to denuded skin. Therefore, side effects are expected and must be differentiated from complications. Nearly all patients encounter minor side effects ranging from postoperative pain and edema to pruritus and tightness.

- Postoperative edema (swelling) may occur, which usually subsides with cold compresses and nonsteroidal anti inflammatory drugs.
- A mild serous (watery) discharge is seen, which subsides spontaneously by the 2nd or 3rd postop day.

Postoperative wound care varies considerably depending on the surgeon's preference. Wounds re-epithelialize more rapidly in a moist environment. Also, crust and eschar impede keratinocyte migration and retard the healing process. Therefore, most surgeons advocate maintaining

a moist environment either with topical emollients and/or with semi occlusive dressings.

Postoperative wound care can follow an open or closed method. With the closed method, a semiocclusive dressing (usually involving a hydrogel) is placed on the denuded skin. These wound dressings have been shown to accelerate the rate of re-epithelialization by maintaining a moist environment. In addition, decreased postoperative pain has been reported with their use. However, some authors believe that occlusive dressings also yield a low-oxygen environment that may promote the growth of anaerobic bacteria, thereby causing infection and impeding wound healing. As such, many proponents of the closed technique now combine the use of semiocclusive dressings with topical emollients. Others simply advocate the use of an open postoperative method involving the application of copious amounts of topical emollients to promote rapid re-epithelialization without risking prolonged occlusion and inability to observe the wound surface. Avoidance of undue sun exposure and use of broad spectrum sunscreens is mandatory.

Complications after laser resurfacing

Minor complications although frequent, are usually of minimal consequence and include milia formation, perioral dermatitis, acne and/or rosacea exacerbation, contact dermatitis, and post inflammatory hyperpigmentation. Hyperpigmentation (darkening) or erythema (redness) over the treated area is common in coloured skin and causes anxiety to patients. However, this is temporary, lasting for only about six weeks and gradually improves.

More serious complications include localized viral, bacterial, and candidal infection, delayed hypopigmentation, persistent erythema, and prolonged healing. The most severe complications are hypertrophic scarring, disseminated infection, and ectropion. Early detection of complications and rapid institution of appropriate therapy are extremely important. Delay in treatment can have severe deleterious consequences including permanent scarring and dyspigmentation.

CONCLUSION

The CO_2 laser is a time-tested machine for treating benign growths, scars and age-related changes in the skin. However, the technique needs proper training, particularly when used for full-face resurfacing. Its use is associated with a significant healing time and postoperative changes such as crusting, pigmentation changes. Patients need to be counseled properly about these aspects of the CO_2 laser; as in all aesthetic treatments, proper counseling and case selection are important.

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Carbon dioxide laser resurfacing surgery consent form

Date_____

Patient's name_____

Age_____

Sex_____

Occupation_____

Address_____

_____

Venue of surgery_____

Proposed Date of surgery_____

I understand

- that the time to recovery after laser resurfacing of the face with the carbon dioxide laser is four months
- That my face will be covered with a bandage for 4–7 days after surgery
- That I will need to use hydrocolloid dressings on my own for up to one month following surgery
- That my face will be pink after surgery for up to one month
- That it will turn deep brown thereafter and will return to its normal colour with the advised treatment over the next three months
- That I agree to scrupulously avoid sunlight during this period in addition to using a sunscreen and an umbrella
- That there is some risk of the treated area becoming permanently sensitive to sunlight
- That there is some risk of the treated areas being permanently lighter or darker than the surrounding skin
- That the skin in the treated areas may heal at a slightly higher or lower level compared to the surrounding skin

_____

Signature of patient