Ultrapulse carbon dioxide laser resurfacing and facial cosmetic surgery

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DB Apfelberg. Ultrapulse carbon dioxide laser resurfacing and facial cosmetic surgery. Can J Plast Surg 1995;3(3):133-136. Over 100 patients have been treated with the ultrapulse carbon dioxide laser since July 1994. The high power square wave pulse of 600 watts at less than 1 msec (which is less than the thermal relaxation time of tissue) dissipates heat during vaporization, thus producing a 'cold beam' and decreasing thermal injury. Similarly, hemostatic incision may be achieved by the focus beam at short repetition rates allowing incision with simultaneous coagulation of small vessels. Seventy-four patients underwent resurfacing for rhytides and photo aging with excellent cosmetic results and no texture or pigmentary change. Facial cosmetic surgery (facelift/eyelid lift/forehead lift) was accomplished in 41 patients using the laser scalpel. Patient selection, preparation, sequence of the laserbrasion and incisional techniques are summarized.

Key Words: Carbon dioxide laser, Laserbrasion, Resurfacing, Transconjunctival blepharoplasty, Ultrapulse

Traitement par dermalaser ultrapulsé et chirurgie esthétique

RÉSUMÉ: Plus de 100 patients ont été traités à l'aide du laser au gaz carbonique ultrapulsé depuis juillet 1994. Les ondes carrées pulsées de forte puissance, 600 watts en moins d'une milliseconde, (ce qui est moindre que le temps de relaxation thermique du tissu) dissipent la chaleur durant la vaporisation, ce qui produit un <<faisceau froid>> et atténue la lésion thermique. De même, l'incision hémostatique peut être obtenue à l'aide d'un faisceau focalisé à des taux de répétition brefs, ce qui permet une incision et une coagulation simultanées des petits vaisseaux. Soixante-quatorze patients ont subi un traitement par dermalaser pour rides et vieillissement actinique avec des résultats esthétiques excellents, sans modification de texture ou de pigmentation. La chirurgie esthétique faciale (redrapage au niveau du visage, des paupières et du front) a été effectuée chez 41 patients à l'aide du bistouri-laser. Le choix des patients, leur préparation, les étapes du traitement par dermalaser et les techniques d'incision sont résumées ici.
Since July 1994, the ultrapulse carbon dioxide laser has been used in facial cosmetic surgery in my practice. This report summarizes the experience with over 100 patients. There were 41 patients who underwent facelift/blepharoplasty/forehead lift using the laser as a scalpel and 74 patients who underwent resurfacing of various facial areas (Tables 1 and 2). Sequence of the laserbrasion and incisional technique, as well as patient preparation, selection, and postoperative care are detailed.

### TABLE 1: Resurfacing – Patient and treatment data

<table>
<thead>
<tr>
<th></th>
<th>Number of patients</th>
<th>Average age</th>
<th>Healing days</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peri-oral</td>
<td>40</td>
<td>38.9</td>
<td>9-11</td>
<td>2 scars (lip)</td>
</tr>
<tr>
<td>Eyelid</td>
<td>20</td>
<td>46.7</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Full face</td>
<td>3</td>
<td>41.3</td>
<td>8-10</td>
<td>0</td>
</tr>
<tr>
<td>Scar</td>
<td>7</td>
<td>24.6</td>
<td>6-8</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>34.5</td>
<td>5-7</td>
<td>0</td>
</tr>
</tbody>
</table>

### TABLE 2: Cosmetic surgery – Patient and treatment data

<table>
<thead>
<tr>
<th></th>
<th>Number of patients</th>
<th>Average age</th>
<th>Sex</th>
<th>Bruising (days)</th>
<th>Average blood loss (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blepharoplasty</td>
<td>20</td>
<td>47.2</td>
<td>4M, 16F</td>
<td>10.1</td>
<td>14.8</td>
</tr>
<tr>
<td>Meloplasty/blepharoplasty</td>
<td>18</td>
<td>59.3</td>
<td>2M, 16F</td>
<td>10.4</td>
<td>137.4</td>
</tr>
<tr>
<td>Forehead</td>
<td>3</td>
<td>54.6</td>
<td>1M, 2F</td>
<td>8.9</td>
<td>123.2</td>
</tr>
</tbody>
</table>

F Female; M Male

**ULTRAPULSE CARBON DIOXIDE LASER PHYSIOLOGY**

The Coherent Ultrapulse™ 5000 CO2 laser is used in the ‘ultrapulse’ mode. To achieve the higher powers that would normally be possible if the laser was operated on a continuous (CW) or superpulsed mode, the laser tube is supercharged with high doses of radio frequency energy for a very short time (pulse). The ultrapulse can, thus, achieve high power over one-millionth of a second. The pulses may be repeated at a certain repetition rate (pulse per second equals Hertz). Laser settings which would yield an average power of 5 watts include a repetition rate of 20 Hertz, pulse width of 314 microseconds, and energy per pulse of 250 millijoules (mJ). The clinical results is skin vaporization or incision without char or excessive thermal injury to tissue. Since the thermal relaxation time of skin is established to be approximately 695 to 700 microseconds, the short pulse does not allow accumulation of heat. Also, the delay between pulses permits the minimal level of heat that has accumulated in surrounding areas to dissipate before the next burst of laser energy is delivered. The result is extremely precise vaporization or cutting with minimal risk of scarring or prolonged healing time from unwanted thermal damage. The ultrapulse carbon dioxide laser, thus,
represents a significant advance over previous continuous wave carbon dioxide laser
technology, as it comes close to achieving a 'cold incision' (1-3).

**LASER ASSISTED MELOPLASTY/ BLEPHAROPLASTY/FOREHEAD LIFT**

The laser handpiece is held at the focal length and directed toward tissue which is
placed on traction for easier separation. Before tissue application, the laser is directed
toward a moistened tongue blade to check alignment. Using 3 to 5 watts of power, 15 to
25 mJ, and a 0.2 mm spot size, excellent hemostatic cutting may be achieved. Skin,
subcutaneous tissue, fat and muscle are easily incised. Defocusing the laser beam permits
tissue coagulation. Since there little or no adjacent tissue thermal damage, it is not necessary to
cut back wound edges before closure as with the YAG laser. The CO2 laser has now
supplanted the YAG laser with contact sapphire tips in my practice (4,5,6,7).

Facelift flaps can be undermined easily and almost bloodlessly for a distance of 3
to 5 cm with one exception -- transection of large lumen superficial temporal vessels.
Deeper or longer flap undermining is aided by injection and distention of multiple
adjacent tunnels with a 14 gauge spatula tip needle and local anaesthesia with adrenaline.
The separations between the injected tunnels are then connected with the laser. Care is
taken to keep the dissection at the proper level and to avoid 'button-holing' the skin.
Platysma and SMAS dissection may be performed with the laser providing a bloodless
field for proper observation of important anatomical structures such as facial nerves and
muscles. No stimulation of the facial nerve, as seen with electrocautery, results from laser
contact. Frequently, no further hemostasis is required after laser dissection. Flap
advancement and closure is identical to standard facelift techniques.

Eyelid surgery is performed in a similar manner with some minor modifications.
Protective eye shields are inserted over the cornea after application of ophthalmic
anaesthetic and antibiotic ointment and are removed immediately following the procedure
to prevent corneal edema. Skin, muscle and fat may all be resected with the laser without
the necessity for cross-clamping or crushing of these structures. Blood loss frequently is
reported at 0 to 5 mL for all four lids. Transconjunctival blepharoplasty may be
accomplished safely and bloodlessly as well. The laser has no electrical potential so fat
may be draped directly across a small metal retractor and removed without fear of electric
transmission and burning of the skin. Moistenred applicators should be used as a
'backstop' behind tissue that is elevated for removal by the CO2 laser so that the beam
will not strike tissue beyond the area to be removed.

**ULTRAPULSE CARBON DIOXIDE LASER RESURFACING**

The laser, aided by 4.5 power surgical loops, is able to remove 100 µm slices of
skin in a bloodless manner (Figure 1). The ultrapulse laser produces a chain of rapid short
pulses rather than a single continuous pulse. Due to the high power square wave pulse of
600 watts at less than 1 msec (which is less than the thermal relaxation time of tissue), all
heat is dissipated during vaporization rather than being conducted, thus producing a truly
'cold beam' with very little risk of thermal damage and subsequent burn scars. As each
layer is precisely removed, the operator can observe the remaining tissue for high points
and irregularities and these can be selectively smoothed on subsequent passes until
smooth upper dermal contour can be achieved. Depth through the epidermis and into the
papillary or reticular dermis can be readily observed by colour changes in the tissue as well as observations of shrinkage of collagen. Twin benefits of physical smoothing of the surface irregularities and heat shrinkage in type I collagen secondary to heat production at 55 to 60 degrees C provide immediate and long lasting benefits.

Figure 1) Illustration of depth of tissue destruction at 450 mJ setting. Each pass removes 100 mm of skin. With a collimated handpiece, the fluence to tissue is precisely controlled by adjusting the pulse energy. The depth of ablation with the Ultrapulse can be adjusted by varying the pulse energy from 1 millijoule to 500 millijoules. (Data from R Fitzpatrick, MD, Courtesy Coherent Inc.)

The sequence of the ultrapulse laser resurfacing is fairly standardized now among thought leaders. The process is accomplished as follows. Before regular or intravenous sedation anaesthesia in the operating room, rhytides are first marked to identify them prior to distortion by the local anaesthesia. A weak adrenaline solution (no stronger than a 1:200,000) is used so severe vasoconstriction will not obliterate the colour indicators of depth (which are described later).

Complete superficial laserbrasion observing anatomical areas is done at 450 to 500 mJ, 3 to 5 watts, 10% overlap to remove the epidermis and reveal the underlying irregularities. The desiccated tissue is then wiped clean with a very moist saline gauze with complete removal. The surface is dried since excess water would absorb the laser energy and two to four subsequent passes can be made at 350 mJ, 3 to 5 watts to remove the 'shoulders' or high points of the rhytides, furrows or scars (Figures 2, 3) The thickness of the skin established in the preoperative evaluation must be respected as well as observance of variation in zonal areas (ie, fewer passes in thin eyelid skin, more passes to thick photo-aged cheeks). A reddish-pink colour indicates removal of the epidermis. A uniform grey appearance signals achievement of the depth of the papillary dermis and a
chamois yellow appearance heralds tissue removal down to the reticular dermis. It is better to stop at this point and re-do the area in two to three months rather than risk scarring by too deep removal of tissue on the first treatment. Edges of the regular areas are feathered to prevent a sharp line of demarcation by 'paint brushing' a random pattern with gradual decreasing powers of the laser, random pattern with the same power, or 35% trichloroacetic acid.
Patient selection includes fine static rhytides, perioral or periocular wrinkles, full face photo ageing, acne and chicken pox scars (Figures 4, 5). Special caution is necessary for patients who have a keloid history, have taken isotretinoin in the past 18 months, or who develop frequent oral herpes infection. Darkly pigmented and severely photo aged patients are frequently pretreated with 'Kligman's' mixture of tretinoin, hydroquinone and cortisone (8). Care following treatment includes closed application of occlusive semipermeable dressings (Vigilon, Omniderm, Flexzam, etc) or open treatment with frequent application of topical moisturizing agents (Vaseline, Preparation H, bacitracin) accompanied by vinegar/water (1/4% acetic acid) compresses. A moist environment aids in re-epithelialization and drying, crust ing and scabbing are to be avoided. Side effects or complications are treated as follows: hypertrophic or keloid scars with intralesional steroids; erythema with topical cortisone; pigmentation with bleaching agents; bacterial and herpetic infections with antibiotics/antiviral agents.

DISCUSSION

The availability of the laser has revolutionized my practice. Patients who would have undergone traditional external subciliary skin/muscle lower blepharoplasty with external scar and risk of ectropion, are now routinely treated with a transconjunctival approach combined with laser resurfacing of the lower eyelid and crow's feet area. This results in a safer operation with smooth, tight, rejuvenated looking eyelid skin with little risk of ectropion (Figures 6, 7). In addition, malar pouches, cheek pads and lateral smile lines can be significantly improved with the laser. Upper blepharoplasty is accomplished with the carbon dioxide laser as well. Skin muscle and orbital septum, as well as fat excision, can all be done bloodlessly with the laser. The usual scars heal as well as scalpel excision. Average blood loss for upper eyelid laser blepharoplasty is 14.8 mL and the last bruising and swelling is completely gone in an average of 10.1 days. It is rare to observe any change in lid position after transconjunctival lower blepharoplasty and resurfacing with the laser. No cases of ectropion or 'scalloping' have been produced. In fact, patients with preoperative and pending or actual scleral show are ideal choices for this procedure.

Laser skin resurfacing has replaced chemical peel and dermabrasion in my practice. It allows precise control, is bloodless and heals well with minimal risk of scar, texture or pigmentary changes. Laserbrasion is truly micron surgery with excellent visibility. Most facelift patients can benefit from perioral resurfacing which enhances and compliments the overall result. Regional areas such as perioral and periorbital may be smoothed as an isolated procedure or part of total facial rejuvenation. Patients with facial wrinkles who are not good candidates for surgical facelifts because of medical contraindications or too many previous facelifts can also be helped, as can patients with scars and photo aging.

REFERENCES