Laser-Assisted Microphonosurgery

4b

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Core Messages

- Carbon dioxide (CO_2) laser should be regarded as complementing the existing instrumentation. It is not meant to replace well-established microlaryngoscopic techniques.
- Newcomers to laser technology must first be competent in the microlaryngoscopic technique. Then they can learn the lasers and their tissue effects as continuing professional development.
- Thanks to the development of the high-powered pulsed waves, the micromanipulator Acuspot, and the scanning device, laser-assisted surgery can be approached in a safe way provided that the parameters are strictly respected.

Most glottic lesions affect phonatory function of the larynx. Surgical management aims at removing of these lesions and restoring phonation. The procedure should be precise, and the healing process should not result in significant scarring. Microlaryngoscopic technique with high-quality instruments and their proficient use by skilled surgeons has done much to achieve this goal during the past few decades [4]. The use of lasers in phonomicrosurgery was first described three decades ago [7].

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Introduction of CO_2 laser [17] should be regarded as complementing the existing instrumentation. It is not meant to replace well established microlaryngoscopic techniques. Recognizing this limited but important role of laser, a term "laser-assisted procedure" seems more appropriate than "laser surgery." It is thus obvious that a newcomer to laser technology must first be competent in microlaryngoscopic technique and then learn the lasers and their tissue effects as continuing professional development.

With surgery on the vocal cord, the primary aim is to preserve the underlying vocal ligament. The usual morphological anatomy of the vocal fold is described as having a superior and an inferior surface, with an intervening free edge. However, the free edge is far from an "edge." The dynamic anatomy of the vocal fold shows three distinct "borders" to the free edge: superior, middle and inferior.

If the superior border of the free edge is surgically removed, the mechanical vibration continues from the inferior border to the middle border, and the voice generally recovers within 2–6 weeks. When both the superior and the middle borders are removed simultaneously, recovery of the vibration usually takes longer, 4–6 weeks. Removal of all three borders prolongs recovery of the vibration to 8 weeks or more, and the risk of developing a permanent scar is increased. Worse still, the scar may retract within the substance of the fold. To avoid this condition, it is advisable to leave a strip of epithelium intact.

Thanks to the development of the high-powered pulsed waves (SuperPulse or UltraPulse) and the micromanipulator Acuspot, laser-assisted surgery can be approached in a safe way provided the parameters are strictly respected. This is even more true with the robotic or digital scanning device (see Chapter 3).

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Fig. 4b.1. Scanning device connected to the laser arm and the micromanipulator. The scanning device is guided by the Acublade software

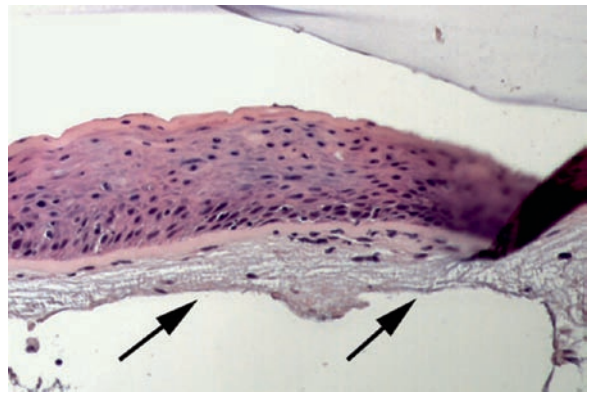

Fig. 4b.2. Histological specimen from a nodule resected with a CO_2 laser scanning system. Coagulation at the margin (arrows) is no more than 20 μm. (H&E, ×20)

Recommended laser settings in phonosurgery without the scanner are SuperPulse or UltraPulse, 0.1-second exposure duration of 2–3 W with a focused beam that has a 250 μm spot size for a working distance of 400 mm. If microvasculature coagulation is required (e.g., chorditis vocalis or Reinke's edema) before incising the epithelium, the laser is set at 0.05-second pulsed exposure of 1 W with a slightly defocused beam.

With the scanning system (Fig. 4b.1), the proposed parameters for phonosurgery are depth of 0.2 mm, 10 W, single pulse, 0.10 s for SuperPulse and two passes, 10 W, single pulse, 0.10 second for UltraPulse. The length of the incision line or the diameter of surface to ablate was 1–2 mm depending on the lesion.

Beam parameters are for guidance only. A number of factors affect the ultimate effect of the beam on the pathological (and normal) tissue. The type of laser used, the lifespan of the device, the make, and the experience of the surgeon all have a bearing on the outcome.

The CO_2 laser controls bleeding from blood vessels up to 0.6 mm by shriveling the tissue. Oozing can be controlled by ice-cold cottonoids held in position for a few seconds or swabs soaked in suitable decongestant. Any bleeding from large vessels is controlled by monopolar diathermy, which is incorporated in the forceps. Dilated and varicose vessels can be obliterated by defocusing the beam slightly. In the defocused spot, the energy concentration is reduced, and tissue is coagulated.

The thickness of thermal-damaged tissue in the case of benign lesions of the vocal fold is usually no more than 20 μm [12] (Fig. 4b.2). This explains the stroboscopically observed reduction in postoperative healing time, compared with that obtained with cold instruments.

Laser phonomicrosurgery for benign lesions is functional surgery, and careful selection of patients is critical for a successful outcome. Particular care should be taken with voice performers because even the most minor anatomical removal may not restore the quality of voice on which the performers have built their careers. The extent of scarring from the excision can be controlled by meticulous attention to details, particularly regarding the laser effects that are beyond visual control [3]. Furthermore, the eventual healing by scar tissue and its effect on vibratory margin cannot be predicted with any degree of certainty. It is necessary to convey this to the patient unequivocally in a way that he or she understands, so that he or she is in a position to give informed consent.

Microsurgery of the phonatory disorder and voice therapy are inseparable [8]. This dual management strategy varies according to the lesion. In some cases, voice therapy is the initial treatment. When voice therapy fails or symptoms return because of recurrence, surgery is inevitable. In other cases, surgery is the initial treatment, followed by a course of voice therapy. The following examples illustrate the difference.

- When hoarseness is due to nodules that are formed owing to dysfunctional dysphonia, a course of voice therapy resolves the condition in most cases. Similarly, adequate improvement follows voice

therapy in cases where hoarseness is due to minor sulcus, scar, or chorditis vocalis. Surgical intervention should be considered only in cases that fail to respond or that recur.

- Hoarseness due to Reinke's edema, cyst, or extensive sulcus requires initial surgical management. After a period of voice rest, a course of voice therapy is undertaken.

The choice of the surgical instrument depends on the experience and expertise of the phonosurgeon [10]. In the hands of some surgeons, skillful surgery with cold instruments can produce acceptable results [15]. For certain lesions, such as nodules, edematous polyps, mucous retention cysts, and epidermoid cysts, CO_2 laser has no particular advantage over the cold instruments. However, the authors prefer laser instrumentation for certain conditions such as hemorrhagic polyps, Reinke's edema, and sulcus or sulcus vergeture [14].

The continuous mode should never be used because of increased irradiance of tissues in this mode. In the pulse mode, the thermal damage is only a few microns deep. The absence of an adverse deep thermal effect after a CO_2 laser-assisted micropoint incision or dissection is demonstrated by Andrea's contact endoscopy [1], showing persistence of microvasculature flux of erythrocytes in Reinke's space.

Microsurgery is preferable under general anesthesia for a number of reasons. Preoperative assessment, based on videostroboscopy, may identify the vibratory disorders, but the precise nature and the extension of the pathology may not be fully apparent. "Instrument palpation" carried out under general anesthesia is useful for accurate, precise assessment. The cords should be routinely everted and the subglottis examined. A 70° telescope passed through the cords shows any lesions in the subglottis and upper trachea. An examination of the upper aerodigestive and lower respiratory passages must be carried out in cases of recurrent respiratory papillomatosis (RRP) to exclude their involvement.

There is a major trend [2, 11, 16] among North American laryngologists to perform office-based procedures whenever possible, including injection of materials for glottic gap, injection of *Botulinium* toxin for spasmodic dysphonia, biopsies, PDL laser-assisted procedures such as vaporization of papilloma, lesions of the free edge such as nodules, or polyps. The financial advantage is obvious, but the risk of poor functional results in comparison with the procedures performed under general anesthesia and the criteria of selection are not yet evaluated.

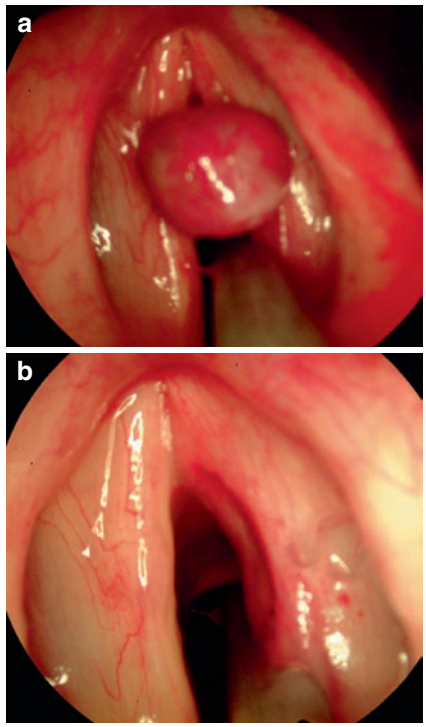

Fig. 4b.3. Angiectatic polyp. (**a**) Before surgery. (**b**) After resection)

Two techniques are employed most extensively: excision and dissection. Excision is indicated for nodules, polyps, small sulcus (referred to as opened cysts by Cornut and Bouchayer), a mucosal bridge, mucous retention cysts, epidermoid cysts, and granulomas. The lesion is grasped with a Bouchayer microforceps (Bouchayer; Micro-France, Paris, France) and stretched toward the midline to define the plane between it and the vocal ligament. The laser is used in pulse mode to cut the stretched fibers in the plane (Fig. 4b.3a, b).

In contrast, dissection is preferred for Reinke's edema, a large sulcus, and a scar. For Reinke's edema, the microvasculature on the superior surface of the vocal cord is coagulated first. The epithelium is then incised close to the lesion, along the length of the superior surface, from the vocal process to within 2–3 mm from the anterior commissure [6, 14]. Once the incision is made, the free margin is drawn toward the midline with the Bouchayer microforceps, and the gelatinous material is aspirated. The microflap is then

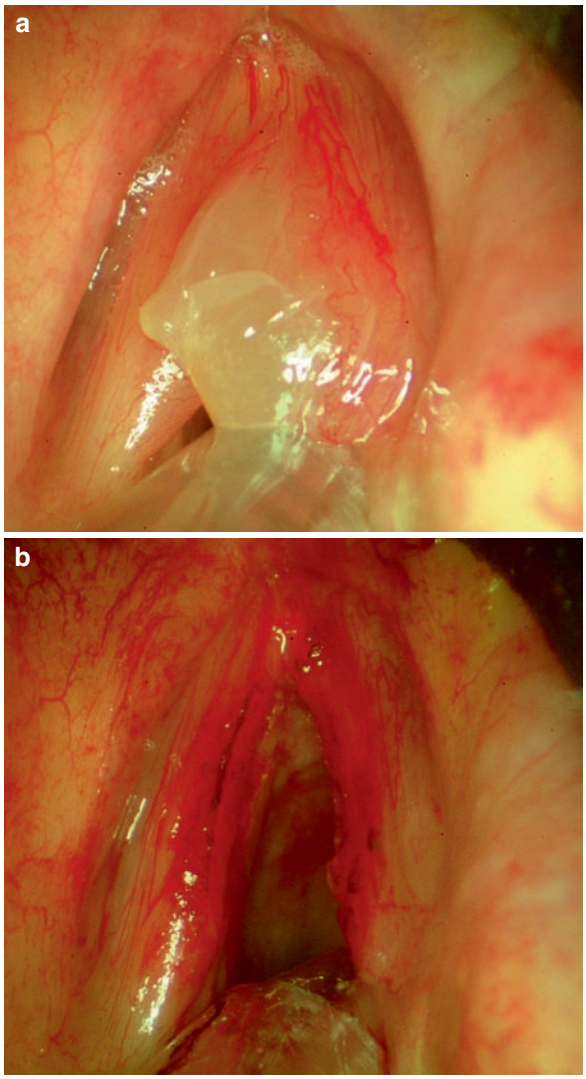

Fig. 4b.4. Reinke's edema. (**a**) Before surgery. (**b**) After dissection and suction of the glue. The excess epithelium has been cut

re-draped. The excess epithelium, if any, is trimmed to achieve the best possible approximation of the incision edges. Provided a 2- to 3-mm strip of intact mucosa close to the anterior commissure is spared, surgery may be carried out simultaneously on the two sides (Fig. 4b.4a, b)

For the sulcus or a scar, the technique developed by Bouchayer [5] is employed. The incision begins on the superolateral edge of the lesion. Then, using the Bouchayer microforceps, the inner edge of the incision is grasped, and careful dissection is performed along the epithelium. During the dissection, it is advisable to grasp the entire dissected epithelium to separate it from the vocal ligament all the way to the inferior surface of the vocal cord. Small cottonoid pledgets, soaked in a solution of physiological saline and epinephrine cooled to 5°C, are used to control minor superficial bleeding and remove tissue debris. After completing the surgery, a few drops of slow-setting fibrin glue (Tissucol; Immuno, Vienna, Austria) is applied, either for covering the excision field or for re-draping the microflap. The specimen is systematically oriented and sent for histological examination. An accurate histological examination is not impaired by the presence of char and coagulation, which extends only a few microns deep.

Although the use of fibrin glue is somewhat empirical, the authors subscribe to the view of Bouchayer [4] that it is useful for covering the site of the operation. It possibly acts as scaffolding for regeneration of epithelium and discourages any potential to granuloma formation. To date, no short-term or permanent side effects have been observed.

Following phonosurgery, strict 8-day vocal rest is prescribed. Medical treatment consists of steroid aerosols and oral antibiotics for 8–10 days, at the end of which time assessment takes place. Thereafter, the patient may resume phonation under the supervision of a speech therapist. The postoperative stroboscopic examination of small lesions shows a good recovery of vibration amplitude and return of the mucosal wave along the superior surface of the vocal cord. The vibration is usually symmetrical after surgery for a nodule. However, the vibration may remain slightly asymmetrical following an intervention for a polyp, a mucous retention cyst, an epidermoid cyst, or a small sulcus. This asymmetry, however, does not result in diplophonia.

The recovery time is directly related to the extent of the surgical procedure. The more extensive the dissection, the longer the recovery of the vibration: 3–4 weeks for Reinke's edema and 3–4 months for a large sulcus or a sulcus vergeture [13]. In the case of a sulcus vergeture, although the vibration improves it is not normal. The spindle-shaped glottic aperture is smaller but still apparent. Even if the amplitude returns to normal, the vibration frequently remains asymmetrical during phonation. At times, a mucosal wave can be identified.

The minimum follow-up period is 3 months for Reinke's edema, a polyp or a mucous retention cyst; 4 months for a small sulcus; 5 months for a scar or a sulcus vergeture; and 6 months for a nodule.

Following phonomicrosurgery, voice therapy is indispensable [9, 18]. The duration varies according to the severity of the surgery and the individual patient. The sulcus vergeture requires prolonged speech therapy (up to 6 months) because the therapy must suppress the hyperkinetic compensatory mechanisms adopted by the patient before surgery. Furthermore, although the aim of the surgery is to correct the glottic gap and fibrosis, surgery itself induces a certain degree of fibrosis (although always less than the preoperative state). Following surgery for a nodule, a polyp, a mucous retention cyst, or a small sulcus, there is subjective recovery to a normal voice. The outcome is maintained provided any functional dysphonic element is properly corrected by voice therapy. After surgery for Reinke's edema, the pitch of the voice improves, particularly in women, and the voice quality remains satisfactory provided the patient discontinues smoking.

After an intervention for sulcus vergeture, the patient perceives improved phonatory ease, reduced vocal fatigue, and a steady improvement in timbre. Breathiness, hoarseness, and the episodes of vocal instability decrease. The projected voice improves, but it does not return to normal. Complete anatomical and physiological restoration of the vocal cord cannot be achieved. It is therefore necessary to tell the patient the limitations of the phonatory outcome and ensure compliance to extensive voice rehabilitation.

4b.1 Tip and Pearls

- Recommended laser settings in phonosurgery without the scanner are SuperPulse or UltraPulse, 0.1 second exposure duration of 2–3 W, with a focused beam with a 250 μm spot size for a working distance of 400 mm.
- If microvasculature coagulation is required (e.g., chorditis vocalis or Reinke's edema) before incision of the epithelium, laser is set at 0.05-second pulsed exposure of 1 W with a slightly defocused beam.
- With the scanning system, the proposed parameters for phonosurgery are a depth of 0.2 mm, 10 W, single pulse, 0.10 second for SuperPulse; and two passes, 10 W, single pulse, 0.10 second for UltraPulse. The length of the incision line or the diameter of the surface to ablate was 1–2 mm depending on the lesion.
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- Beam parameters are for guidance only. A number of factors affect the ultimate effect of the beam on the pathological (and normal) tissue. The type of laser used, the lifespan of the device, the make, and the experience of the surgeon have a bearing on the outcome.

References

1. Andrea M, Dias O, Santos A (1995) Contact endoscopy of the vocal cord: normal and pathological patterns. Acta Otolaryngol 115(2):314–316
2. Bastian RW, Delsupehe KG (1996) Indirect larynx and pharynx surgery: a replacement for direct laryngoscopy. Laryngoscope 106(10):1280–1286
3. Benninger MS (2000) Microdissection or microspot CO_2 laser for limited vocal fold benign lesions: a prospective randomized trial. Laryngoscope 110(2 Pt 2):1–17
4. Bouchayer M, Cornut G (1992) Microsurgical treatment of benign vocal fold lesions: indications, technique, results. Folia Phoniatr (Basel) 44(3–4):155–184
5. Bouchayer M, Cornut G, Witzig E, Loire R, Roch JB, Bastian RW (1985) Epidermoid cysts, sulci, and mucosal bridges of the true vocal cord: a report of 157 cases. Laryngoscope 95(9 Pt 1):1087–1094
6. Desloge RB, Zeitels SM (2000) Endolaryngeal microsurgery at the anterior glottal commissure: controversies and observations. Ann Otol Rhinol Laryngol 109(4):385–392
7. Frèche Ch, Piquet JJ, Traissac L, Romanet P, Guerrier B, Brasnu D, et al (1993) Le laser en ORL. Arnette, Paris
8. Giovanni a, Remacle M, Robert D (2000) Phonochirurgie des tumeurs bénignes des cordes vocales. - 16p. Paris, Editions scientifiques et médiacles Elsevier SAS. Encycl Med Chirur, techniques chirurgicales - Tête et cou 46–350
9. Johannsen HS (2001) Phoniatric aspects in microsurgical removal of benign vocal cord changes. Laryngorhinootologie 80(4):226–233
10. Keilmann A, Biermann G, Hormann K (1997) CO_2 laser versus conventional microlaryngoscopy in benign changes of the vocal cords. Laryngorhinootologie 76(8):484–489
11. Milutinovic Z (1990) Advantages of indirect videostroboscopic surgery of the larynx. Folia Phoniatr (Basel) 42(2):77–82
12. Remacle M, Hassan F, Cohen D, Lawson G, Delos M (2005) New computer-guided scanner for improving CO(2) laser-assisted microincision. Eur Arch Otorhinolaryngol 262(2): 113–119
13. Remacle M, Lawson G, Degols JC, Evrard I, Jamart J (2000) Microsurgery of sulcus vergeture with carbon dioxide laser and injectable collagen. Ann Otol Rhinol Laryngol 109(2): 141–148
14. Remacle M, Lawson G, Watelet JB (1999) Carbon dioxide laser microsurgery of benign vocal fold lesions: indications,

techniques, and results in 251 patients. Ann Otol Rhinol Laryngol 108(2):156–164
15. Sataloff RT, Spiegel JR, Heuer RJ, Baroody MM, Emerich KA, Hawkshaw MJ, et al (1995) Laryngeal mini-microflap: a new technique and reassessment of the microflap saga. J Voice 9(2):198–204
16. Simpson CB, Amin MR (2004) Office-based procedures for the voice. Ear Nose Throat J 83(7 Suppl. 2):6–9
17. Strong MS, Jako GJ (1972) Laser surgery in the larynx. Early clinical experience with continuous CO_2 laser. Ann Otol Rhinol Laryngol 81(6):791–798
18. Woo P, Casper J, Colton R, Brewer D (1994) Diagnosis and treatment of persistent dysphonia after laryngeal surgery: a retrospective analysis of 62 patients. Laryngoscope 104(9): 1084–1091