Infant Frenectomy with 10,600 nm Dental CO_2 Laser

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The waxing and waning of opinion about the impact lip-tie and tongue-tie have on infants' breastfeeding and speech — and even the condition's actual existence — remain the foundation of the passionate dialectic that influences today's opinions on the subject. Modern literature on frenectomy[1-3] indicates that there is no legitimate reason to withhold treatment of tongue-tie in an infant, child, or adult. The resistance to performing such a simple surgical procedure as frenectomy boggles the mind when so much research demonstrates its effectiveness and safety. Multidisciplinary efforts[1] to end the perpetuation of tongue-tie myths generated throughout time have helped change the global dialogue from one of intense criticism of treatment for tongue-tie to one of grudging acknowledgment that tongue-tie has a negative impact on breastfeeding and should be managed and treated for optimal clinical results. Breastfeeding problems associated with infants' Tongue- and Lip-Ties manifest themselves through infants' failure to thrive and include, but are not limited to: inability for baby's lips, mouth and tongue to properly latch on mother's breast; inability to stimulate milk production through vigorous nursing, resulting in low milk supply; improper tongue mobility may prevent babies from clearing milk from their mouth; painful nursing, colic, reflux, speech difficulties; sleep deprivation for mother and infant due to frequent feedings; etc. Together with lactation consultants, oral surgeons and dentists have a role in both squelching the myths about lip-tie and tongue-tie's existence but also about the safety and efficacy of proper diagnosis[1,2] (see Figure 1) and timely treatment using the best modern methods and tools, such as soft tissue dental lasers.[3]

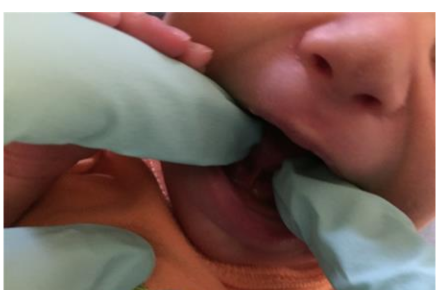

Figure 1. Lingual frenum assessment by Alison K. Hazelbaker, PhD, in progress.

ORAL SOFT TISSUE LASER SURGERY

The 10,600 nm CO_2 laser is a "What You See Is What You Get" surgical soft tissue cutting laser with minimal collateral thermal effects[3,4] that are sufficient for sealing blood vessels, lymphatics, and nerve endings; the surface bacteria are efficiently destroyed on incision/ablation margins.

CO_2 Laser Photo-Thermal Ablation and Coagulation. The soft tissue photo-thermal ablation is a process of vaporization of intra- and extra-cellular water near the surface where the laser beam intensity is at its maximum (Figure 2). For a fixed laser beam diameter (or spot size), the volume of the tissue exposed to laser beam is proportional to the optical penetration depth. The 10,600 nm CO_2 laser is highly energy efficient at ablating the soft tissue photo-thermally with very low ablation threshold intensities due to extremely small volume of irradiated tissue because

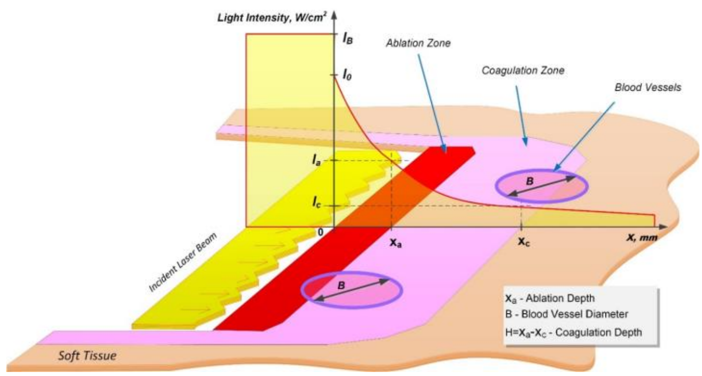

Figure 2. Simplified graphical representation of laser beam intensity attenuated inside the soft tissue.

of very short absorption depth of around 15 µm.[4] Immediately below the ablation zone, the coagulation zone is located (Figure 2). Coagulation occurs as a denaturation of soft tissue proteins that takes place in a 60-100°C temperature range leading to a significant reduction in bleeding (and oozing of lymphatic liquids) on the margins of ablated tissue. For the CO_2 laser, its excellent coagulation efficiency is due to the close match between the photo-thermal coagulation depth of approximately 50 µm,[4] and oral soft tissue blood capillary diameters of approximately 20-40 µm.[5]

Thermal Relaxation Time and Controlling Thermal Effects. The rate of how fast the irradiated tissue diffuses the heat away is defined by Thermal Relaxation Time T_R, which equals approximately 1.5 msec for 75% water-rich soft tissue irradiated by 10,600 nm CO_2 laser. Practical implications of Thermal Relaxation Time concept are simple and yet very powerful for appropriate application of laser energy. The most efficient heating of the irradiated tissue takes place when laser pulse energy is high and its duration is much shorter than T_R. The most efficient cooling of the tissue adjacent to the ablated zone takes place if time duration between laser pulses is much greater than T_R. Such laser pulsing is referred to as SuperPulse and is a must-have feature of any state-of-the-art soft tissue surgical CO_2 laser that minimizes the depth of coagulation.[4]

Laser Beam Spot Size. Just like the sharpness of the steel blade defines the quality and the ease of the cut, the size of the laser beam focal spot defines the quality of the laser cut. The smaller (or sharper) the focal spot of the beam, the narrower and the deeper the incision. Just like a dull blade cannot produce a quality incision, an oversized laser beam spot cannot produce a precise and narrow incision. For a rapid switch from cutting to just photo-coagulation, the laser beam can be defocused either by selecting a larger spot size, or by simply moving the handpiece away from the tissue by approximately 10 mm (for LightScalpel tipless laser handpieces[6]), and "painting" the "bleeder" for enhanced hemostasis – see Figure 3.

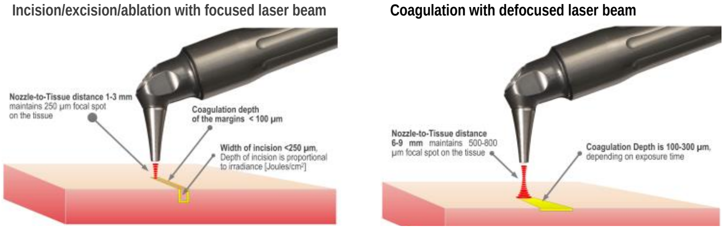

Figure 3. Laser-tissue interaction with focused (250 µm spot size) and defocused (500-800 µm spot size) laser beam. The handpiece is pen-sized, autoclavable and uses no disposables.

Laser Power Density and Depth of Ablation. For a laser scalpel, the power density of the focused laser beam is equivalent to the mechanical pressure that is applied to a cold steel blade: the greater the laser fluence[7] (i.e., greater power density and slower handspeed), the greater the depth and the rate of soft tissue removal – see Figure 4.

Infant Frenectomy Case Study

Patient. A 2-week-old male was referred to Martin Kaplan, DMD, for failure to thrive. Thorough intraoral examination and functional assesment[1,2] were performed along with the interview with the mother. Figure 6a shows the triple thick fibrous maxillary labial frenum; and Figure 7a demonstrates restrictive sub-mucosal lingual frenum. It was determined that the infant required both labial and lingual frenectomy.

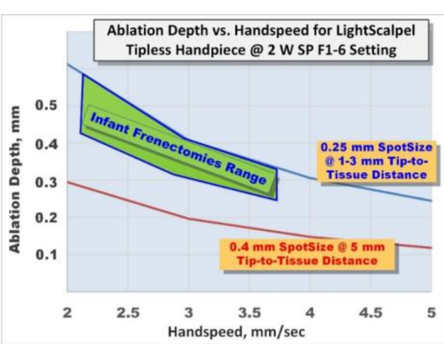

Figure 4. Ablation Depth in water-rich soft tissue with the LightScalpel tipless dental handpiece in 2 watts Repeat F1-6 (20 Hz, 30 msec) SuperPulse (150 Hz, 13 mJoules) mode.

Laser equipment and settings. LightScalpel CO_2 laser LS-2010 (Woodinville, WA) was used at 2 watts SuperPulse repeat pulse F1-6 setting. The surgery was performed utilizing a 0.25 mm tipless angled handpiece[5] (shown in Figures 3 and 5) pointed perpendicular to the target tissue. The depth of ablation did not exceed a fraction of a millimeter per pass (see Figure 4), thus minimizing the risk of collateral damage while requiring multiple passes for the desired tissue removal depth.

Figure 5a. Lip-Tie Release – Surgery in Progress. Note excellent hemostasis.

Figure 5b. Tongue-Tie Release – Surgery in Progress. Note excellent hemostasis.

Surgical Procedure. The patient was positioned in the dental chair with a special headrest and disposable adhesive safety goggles were applied. First, maxillary labial frenum revision was performed. The frenum was visualized and tension was applied to it by pulling the lip upward (traction tension helps laser ablation). Tissue fibers were "erased" in a rapid zig-zaging motion until the junction of the frenum with the labial mucosa was reached. Then the same process continued from the starting point downward to the base of the frenum attachment. The surgical area was periodically wiped with a small gauze pad in order to eliminate any traces of organic ashes from laser plume. Procedure took approximately 30 seconds of laser on time. At the end of the procedure, the lip was pulled upward to check that the motion was not restrained. Hemostasis was excellent (see Figure 6b). No sutures were needed. The post-operative photo (Figure 6b) shows the immediate improvement in the patient's ability to flange the upper lip and the disappearance of the crestal gingiva blanching (compare with Figure 6a).

Second, the lingual frenum revision was performed. The tongue was lifted with a cotton swab. In order to create tension, the surgeon wore a sterile fabric "sleeve" on the index finger to slightly push on the tongue and keep it in place (as seen in Figure 5b). The assistant slightly pushed on the lower lip to prevent the mouth from closing. Superficial tissue ablation started approximately 4-5 mm above the salivary glands' ducts in short horizontal back and forth strokes. The tissue response easily "opened up", noticeably releasing tension. The surgeon ablated the remaining fibers, taking caution to avoid the salivary ducts. Immediately post-operative photo (Figure 7b) shows complete lack of hemorrhage and the increased range of the tongue

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motion. The procedure took approximately 5 seconds of laser on time. No sutures were placed.

Post-Operative Instructions and Follow-up Exam. Patient was released with detailed instructions to the mother on how to do stretch exercises for both the tongue and the lip. Patient was able to feed immediately after the surgery and the mother reported improvement in the effectiveness of feeding as well as noticeable relief in breast pain. Patient was seen at 7 days (Figures 6c, 7c and 7d); healing was uneventful: Figure 7d clearly demonstrates the good lift, spread and cupping of the tongue. Baby's latch-on and sucking ability had improved and in 7 days following the surgery he gained 13 oz.

Figure 6a. Triple labial frenum – pre-operative view

Figure 6b. Immediately post-operative view. Note excellent hemostasis.

Figure 6c. 7 days after the surgery. Good, uneventful tissue healing. The surgical site is covered by a layer of coagulum.

Summary

Once properly diagnosed, infant lip-ties and tongue-ties can be safely and efficiently released with the soft tissue 10,600 nm CO_2 laser with predictable and repeatable tissue response, fast ablation and instant hemostasis. The extremely precise cutting, minimal collateral damage, clear and bloodless operating field and, reportedly, relatively minimal postoperative pain make the CO_2 laser the tool of choice for infant frenectomy. CO_2 laser oral surgery also features less wound contraction and reduced scarring in comparison with scalpel incisions.

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Figure 7a. Submucosal lingual frenum – pre-operative view.

Figure 7b. Immediately post-operative view. No hemorrhage occurred. Note the increased range of motion of the tongue.

Figure 7c. 7 days after the surgery.

Figure 7d. 7 days post-operatively – note the good spread, lift and cupping of the tongue.