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The Effect of CO_2 Laser Irradiation on Oral Soft Tissue Problems in Children in Sri Lanka

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ABSTRACT

Objective: **This study was conducted to investigate the effects of CO_2 laser irradiation on oral tissue problems in pediatric cases in Sri Lanka.** ***Background Data:*** **The CO_2 laser is now widely used as an effective surgical tool to cut or ablate soft tissues. However, few studies have reported the effectiveness of CO_2 laser for oral tissue problems in developing countries, where patients tend to have high rates of infection.** ***Materials and Methods:*** **A continuous CO_2 laser (wavelength 10.6 μm; output power 3 or 4 W) was used for the treatment of 76 young patients (aged 1 to 15 years old) indicated mainly for labial or lingual frenectomy, mucocele excision, or other oral pathology.** ***Results:*** **The CO_2 laser was found to have the following advantages: (1) greatly reduced operating time; (2) simple operative procedure; (3) no postsurgical infection; and (4) decreased or eliminated wound contracture and wound scarring.** ***Conclusion:*** **The CO_2 laser proved to be very safe and effective for soft tissue surgery in a developing country.**

INTRODUCTION

There are now four types of lasers used for the treatment of soft tissue problems in dentistry: the CO_2 laser (wavelength: 10.64 μm), Er:YAG laser (wavelength: 2.94 μm), Nd:YAG laser (wavelength: 1.064 μm), and diode laser (wavelength: 810 or 960 nm). The surgical performance of these lasers generally depends on their oscillating wavelengths. The CO_2 laser energy is well absorbed in water, so it is used for cutting or coagulating soft tissue.[1–5] The energy of the Er:YAG laser is highly absorbed in water, so it can ablate hard tissue.[6–8] The Er:YAG laser is used for soft tissue incision, though it coagulates tissue poorly and thus confers inadequate haemostatis.[5,6] The energy of the diode laser and Nd:YAG laser, on the other hand, is scarcely absorbed in water. This results in a deeper penetration of energy into tissue, a property useful for low-power or low-energy laser procedures to reduce pain. The diode laser and Nd:YAG laser are inefficient for cutting soft tissue, despite their effectiveness in coagulating tissue and producing a denatured layer.[3,5]

The CO_2 laser has been evaluated as an effective adjunct in soft tissue surgery in the oral cavity.[1–5,9–16] The device has five important advantages in resecting soft tissue: (1) no bleeding takes place during or after surgery, (2) no sutures are required after surgery, (3) the subject feels no pain after surgery, (4) the operating time is shorter, and (5) infections are easily avoided. These are welcome advantages for the treatment of pediatric dental patients, particularly in areas with inadequate or incomplete public health services such as in developing countries.

The authors had the opportunity to apply the CO_2 laser for the treatment of oral tissue problems in Sri Lanka through an aid program organized and sponsored by the Japan International Cooperation Agency (JICA). The aim of this study was to clarify the effect of CO_2 laser irradiation for the treatment of oral tissue problems in children in developing countries.

MATERIALS AND METHODS

This study was conducted in the Paedodontic Clinic of the Dental Teaching Hospital of the Faculty of Dental Science of the University of Peradeniya in Sri Lanka, under the auspices of an aid program run by JICA. The CO_2 laser was used for the treatment of 76 cases aged between 1 and 15 years, indicated primarily for labial frenectomy, correction of ankyloglossia, mucocele excision, and gingival incision (Table 1).

The CO_2 laser device was a Panalas C05 (Panasonic Co., Ltd., Osaka, Japan) with a wavelength of 10.6 μm, configured

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TABLE 1. AGE DISTRIBUTION OF TREATED CASES

Age (years)	*Labial frenulum*	*Ankyloglossia*	*Mucocele*	*Gingival proliferation, other*
0–2	0	2	1	0
3–5	2	7	2	0
6–8	9	7	7	6
9–11	4	3	5	6
12–15	1	1	3	10
Total	16	20	18	22

to irradiate the light through a hollow fiber with added air in the non-contact mode. The device was fitted with many different types of tips, ranging in diameter from 0.3 to 2.0 mm. The Panalas C05 has two modes of laser irradiation: continuous wave and pulsed wave.

In this study we applied the irradiation in continuous mode with an output power of 3 or 4 watts under local anesthesia in all of the cases treated. The tissue was irradiated in the non-contact mode with a steady airflow blown onto the irradiated tissue and a distance of about 1 mm maintained between the laser tip and tissue surface. A metal tip with a 1.0 mm diameter was used for the sharp incision of tissues.

Records were kept of the following: operation times, patient complaints during and after the operations, and details of the healing process until the wounds were completely healed. Seventy-two of the 76 cases received no analgesics or antibiotics after surgery. Four cases who underwent mucocele excision received either or both of these medications.

RESULTS

Local anesthesia was administered to all of the subjects, but in doses somewhat lower than generally administered when performing conventional treatments with devices such as regular or electric scalpels. The operation time with the CO_2 laser was short, as there was no bleeding during the operations and no need to use sutures after tissue incision or excision (Table 2).

A coagulative layer was clearly formed on the surface of the tissue during the irradiation with the CO_2 laser, which effectively eliminated bleeding during and after the operation. Almost all patients who underwent laser surgery remained at ease during and after procedure, and only 5 of 76 subjects complained of postoperative pain (3 out of 20 cases treated for ankyloglossia, and 2 out of 18 cases treated for removal of a mucocele complained of mild pain for a few days after surgery) (Table 3).

No secondary infection was observed in any of the cases. The coagulation tissue changed into a layer of scab tissue over the irradiated surface within 1 day, and a new epithelium gradually grew from the surrounding tissue, closing inward until the wound surface was fully healed. The patients who underwent labial or lingual frenectomy were completely healed within 1 to 2 weeks. The patients who underwent mucocele resection were healed within 2 to 3 weeks (Table 3). Little scar tissue formed as the wounds healed.

Surgical frenectomy by laser

The frenulum was incised by laser following administration of local anesthesia. The origin of the frenulum was incised using a laser while pulling up the upper lip or tongue. The CO_2 laser was applied to the tissue in the non-contact mode, with a distance of about 1 mm maintained between the laser tip and tissue surface. The frenulum was smoothly incised and the surface was coagulated. In some patients undergoing labial frenectomy, the inter-dental papilla between the central incisors had to be removed. None of the patients required sutures. Fig. 1 shows the details of one patient who underwent labial frenectomy.

Procedure for removal of a mucocele

After the administration of local anesthesia, soft tissue was incised by directing the laser beam vertically about 1 mm away from the junction between the mucocele and adjoining normal soft tissue. Next, the body of the mucocele was grasped securely with tweezers and pulled up by a second operator until the root of the mucocele could clearly be seen. The root of the mucocele was then incised gradually from all directions directly around the mass. The mucocele was relatively easy to remove

TABLE 2. DETAILS OF THE TREATMENT

Procedure	*Local anesthesia*	*Irradiation output power*	*Maximum total irradiation time*	*Suturing*
Labial frenectomy	Done	3 watts	90 seconds	None
Lingual frenectomy	Done	3 watts	2 minutes	None
Excision of mucocele	Done	4 watts	5 minutes	None
Incision of gingiva	Done	4 watts	2 minutes	None

Table 3. Clinical Features after Treatment

	Postoperative bleeding	*Postoperative pain*	*Wound healing (perfect epithelization)*		
			~1 Week	*~2 Weeks*	*~3 Weeks*
Labial frenectomy	None	None	4/16	12/16	—
Lingual frenectomy	None	3/20	4/20	16/20	—
Excision of mucocele	None	2/18	0/18	10/18	8/18
Incision of gingiva	None	None	15/15	—	—

FIG. 1. **Top:** A case requiring labial frenectomy in a 7–year-old child. The patient showed diastema due to a fibrous labial frenulum. **Center:** Immediately after the labial frenectomy. A coagulated surface layer was clearly formed, effectively eliminating bleeding. **Bottom:** Two weeks after the labial frenectomy, the wound has completely healed without scar tissue.

through this procedure, as it contracted under the laser heat. Again, none of the cases required sutures. Fig. 2 shows a case of removal of a mucocele.

DISCUSSION

The CO_2 laser is recognized today as an effective adjunct in soft tissue surgery for the oral cavity.[1–5,9–16] The major advantage of the CO_2 laser is its wavelength of 10.6 μm. The energy delivered at this wavelength is quickly absorbed into wet tissues. The soft tissues of the oral cavity have a water content of more than 60%. When the tissue is exposed to a CO_2 laser beam, there is very little scattering or reflection due to transmission to adjoining non-targeted areas. The beam can penetrate to a maximum depth of 0.2 mm with minimal damage to the surrounding tissues, giving the operator precise control over coagulation, vaporization, and cutting.[17]

We encountered many developmental anomalies such as ankyloglossia, high frenulum attachments, mucoceles, and gingival proliferation in a population of Sri Lankan children who visited the Paedodontic Clinic of the Dental Teaching Hospital run by the Faculty of Dental Science at the University of Peradeniya. We were able to easily excise the soft tissue with little to no bleeding in all cases. This left us with a clear operative field for the procedure, eliminated the need for postoperative sutures, and reduced the operation time. Better still, almost none of the patients complained of pain or abnormal sensations during or after the operations. The children were also very cooperative during laser treatment. These features were especially useful for improving the comfort of the paedodontic patients treated during this study.

Sri Lanka is a developing tropical country with high temperature and humidity throughout the year. In light of the knowledge and awareness of the rural population with regard to infection and the measures in place for infection control, we speculated that the patients might face a higher chance of postoperative infection compared to Japanese patients, due to a lack of postoperative care at home. We were also familiar with a paper reporting a delay in wound healing in a population of Sri Lankans suffering from malnutrition.[18] In our view, these conditions increased the importance of watching closely for postoperative secondary infection. When we had applied the CO_2 laser for labial and lingual frenectomy, mucocele excision, and gingival incision in pedodontic patients in Japan without administering analgesics or antibiotics, the patients experienced few unpleasant feelings and had almost no complaints of pain or postoperative wound infection.[12,15,19] Based on these experiences in Japan, we decided

FIG. 2. **Top:** A case requiring the removal of a mucocele in an 8–year-old child. A round mucocele 10 mm in diameter was found in the lower lip. **Center:** Immediately after removal of the mucocele. There was no bleeding and no need for sutures immediately after the mucocele was removed. **Bottom:** One week after removal of the mucocele. Coagulation tissue covered the wound surface. The patient had no complaints of pain. The wound was covered by new epithelial tissue by the third postoperative week.

to forego antibiotics in all but a few of the cases in this Sri Lankan study as well, in spite of the less extensive public health services offered in Sri Lanka. Wound healing was almost the same as that reported in our previous study in Japan, with no secondary infections observed.

The current explanation for the better wound healing that occurs with the CO_2 laser is that the heat from the laser simultaneously cuts and disinfects the tissue, thereby forming a clear coagulation zone to protect the tissue from external irritation, infection, and contamination. All of these processes favorably influence wound healing, minimizing both scar tissue formation and wound contraction. One group has proposed that the reduced wound contraction and scar formation result from the reduced number of myofibroblasts recruited for wound healing after procedures with the CO_2 laser.[20]

In sum, the CO_2 laser is very effective for soft tissue surgery, but the heat from the excess laser irradiation needed for coagulation damages the soft tissue and may delay healing. When hemostasis cannot be obtained through laser irradiation, the surgeon should suture the wound or control the bleeding by compression. Basic knowledge and mastery of the techniques of oral surgery are requisite for the success of laser treatment.

CONCLUSIONS

Our results clearly showed the following advantages of the CO_2 laser as a vital instrument in surgical procedures.

1. The device efficiently cut soft tissue with minimal bleeding, providing a clear operative field during the operation. There was no need for sutures, as the bleeding was well controlled during and after the procedure.
2. The procedure was simple and less time-consuming.
3. There was no postsurgical infection.
4. Contraction and scarring of the wound was decreased or eliminated.

Considering these advantages, the CO_2 laser procedure proved to be very safe and effective for soft tissue surgery. The procedure is especially welcome and suitable for the treatment of children in developing countries such as Sri Lanka.

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