Ablation of Dental Hard and Soft Tissue with 9.3 µm CO_2 Solea Laser

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_Introduction

As a practicing general dentist, I am always thinking about the next clinical challenge. Like any general dentist, I regularly encounter a vast array of dental problems in need of attention. Having the best instruments at my disposal is of the utmost importance to achieve optimal results. Over the past several years, I have used multiple lasers operating at various wavelengths to manage treatment involving enamel, dentin, alveolar bone and soft tissues of all types. These lasers include erbium (2.9 µm), Nd:YAG (1.064 µm), diode (0.81 µm) and most recently, an all-new CO_2 laser that operates at 9.3 µm. CO_2 lasers operating at 10.6 µm have been around for decades and have long been considered the gold standard for soft tissue ablation, but soft tissue was all that could be cut with that particular wavelength. In this paper, I will discuss how I use the Solea laser (developed by Convergent Dental Inc.), a 9.3 µm CO_2 laser for hard, soft, and osseous tissue. Solea utilises isotopic CO_2 as a medium and uses a wavelength of 9.3 µm. Unlike other lasers, this wavelength has chromophores of both hydroxyapatite and H_2O, allowing it to vaporise all tissue in the oral cavity. In addition to the unique wavelength, Solea is the first and only dental laser to use computer controls to optimise beam delivery. Before a procedure, I simply choose one of the three "tissue types" (Enamel, Dentin, or Soft Tissue). The beam that comes out of the laser has a diameter of 0.25 mm, but computer-controlled motors, called galvos, move tiny mirrors inside the handpiece to create patterns yielding multiple spot sizes ranging from 0.25 mm up to 1.25 mm. The galvos give me the right size pattern for the job at hand. Again, the computer plays a role in making sure that the right amount of energy is delivered in the right size pattern. The combination of a unique wavelength and computer controls make Solea an instrument suitable for a wide range of applications.

Fig. 1a_Pre-operative #27 with fractured amalgam and recurrent decay.
Fig. 1b_Pre-operative radiograph tooth #27.
Fig. 2_Tooth #27 preparation completed.
Fig. 3_Tooth #27 restored.
Fig. 4_Post-operative radiograph of tooth #27.
Fig. 5_Teeth #s 16 and 14 and edentulous ridge #15 pre-operatively.
Fig. 6_Pre-operative radiograph showing inadequate coronal tooth structure #s 16 and 14.
Fig. 7_Pre-operative view #14 DB with arrow as reference point as case progresses.


Fig. 1a

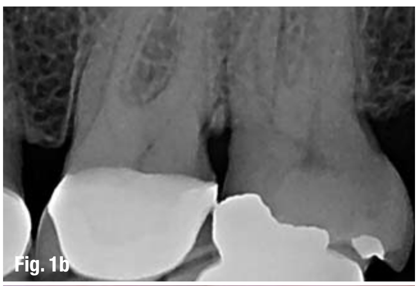


Fig. 1b


Fig. 2


Fig. 3

_Case 1: Fractured amalgam and recurrent decay

The first case exhibits the use of Solea on enamel and dentin. The patient, a 69-year-old female, presented with tooth sensitivity. The exam revealed a fractured amalgam and recurrent decay on #27 MOL (Figs. 1a and 1b). No local anaesthetic was used on this vital tooth, but topical anaesthetic (TAC 20 comprised of Lidocaine 20 % Tetracaine 4 %, Phenylephrine 2 %) was used for the interproximal matrix/wedge. Solea was used to outline the preparation using the Enamel Setting until dentin was reached: 0.25 mm spot size, 15 µs pulse duration, 100 % mist, 20 %–100 % variable speed foot pedal. The amalgam was then removed with a high speed handpiece (Kavo Electrotorque) and 245 bur. I was able to use the bur without anaesthetic because of the profound anal-

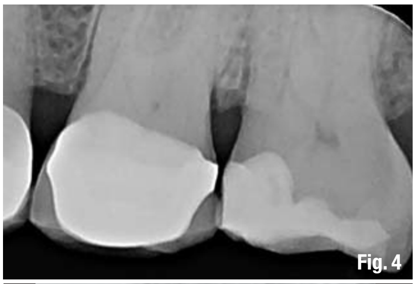


Fig. 4


Fig. 5

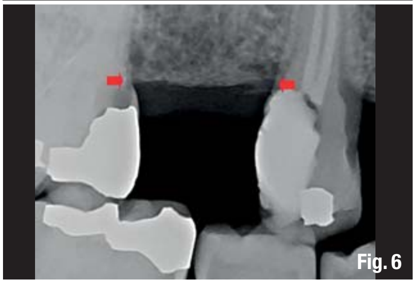


Fig. 6


Fig. 7

gesic effect achieved by starting with Solea. The prep was continued using Solea on the Enamel Setting: 1.00 mm spot size, 15 µs pulse duration, 100 % mist, 10 %–100 % variable speed foot pedal. The prep was completed and decay was removed using Solea on the Dentin Setting: 1.00 mm spot size, 70 µs pulse duration, 100 % mist, 20 %–100 % variable speed foot pedal. The cavosurface margins were beveled with a diamond bur to complete preparation (Fig. 2). The tooth was prepared for restoration with Scotchbond Universal (3M). A layer of Esthet•Xflow (DENTSPLY), approximately 0.5 mm thick, was placed on the gingival floor of the proximal box. Restoration was completed with Tetric EvoCeram Bulk Fill (Ivoclar Vivadent) and finished (Figs. 3 and 4).

Prior to the development of the Solea laser, I would not have considered performing this procedure without anaesthetic; whether I was using an erbium laser, a laser in conjunction with a conventional hand piece or a conventional handpiece alone. Solea's consistent analgesic effect made the procedure easy and predictable, while the precision with a 0.25 mm spot size made it possible to create a gingival trough adjacent to the amalgam without hitting the amalgam itself. A major advantage of not anaesthetizing the patient is that checking occlusion was simplified. Most importantly, it was a better experience for the patient as she reported no discomfort during or after the procedure and was delighted to "not feel numb".

_Case 2: Open flapped crown lengthening

This case involved #s 16 and 14, adjacent to edentulous #15 site (Fig. 5). Seen radiographically with bone level indicated with red arrows (Fig. 6), #16 mesial and #16 distal had inadequate tooth structure due to decay coronal to the alveolus. The patient, a healthy 73-year-old female, was deciding between receiving an implant to replace #14 or a fixed partial denture from #s 16 to 14 with pontic #15. She was encouraged to seek an implant treatment instead of fixed partial denture (bridge) due to longevity, especially with her caries susceptibility. Tooth #14 had endodontic treatment and needs a core and full coverage restoration. Tooth #16 will be treated conservatively with a composite restoration if the patient does not choose a fixed partial denture or full coverage (if partial denture is fixed). For the progression of this case in the photos, a red arrow is used in the distobuccal of tooth #14 to denote a reference point relative to tissue level, etc. See the pre-operative photo of #14 distobuccal (Fig. 7).

The patient was anaesthetized with 1.7 ml septocaine, 4 % with epinephrine 1:100,000 and 1.8 ml of bupivacaine 0.5 % with epinephrine 1:200,000. Solea was used instead of a scalpel for flap incisions. The initial Solea incision was made along the crest of the edentulous ridge using Soft Tissue Setting: 0.25 mm spot size, 65 µs pulse duration, 1 % mist

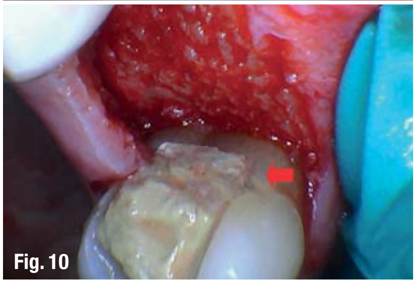
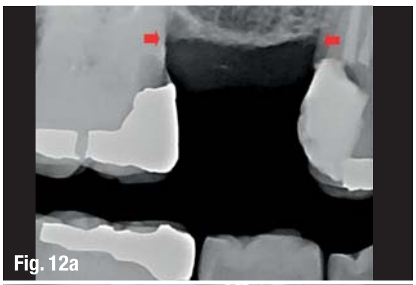
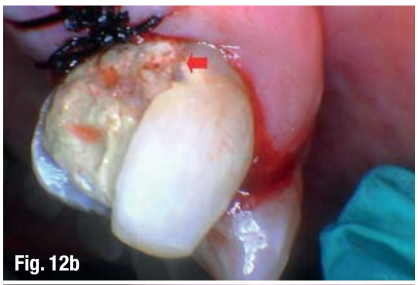


Fig. 8_Initial laser incision along ridge with 0.25 mm spot size.
Fig. 9_Incisions continued with Solea to sever PDLs on adjacent teeth, preparing for flap.
Fig. 10_Alveolar bone ablated to establish biological width. Note arrow at reference point #14 DB.
Fig. 11_Tissue ready for re-approximation and suturing.

Fig. 12a_Radiograph after ablation of alveolus, gaining adequate coronal tooth structure.
Fig. 12b_Note improved tissue level immediate post-operatively.
Fig. 13a_Edentulous ridge five month postoperative.
Fig. 13b_Note tissue level #14 DB compared to pre-operative.





and 50%–100% variable speed foot pedal (Fig. 8). The flap incision was continued using the same settings around #s 16 and 14, severing the periodontal attachment (Fig. 9), while not touching the adjacent tooth. Note the clean, linear precision of the incision with minimal to no bleeding. Next, the periodontal flap was raised using traditional periodontal instrumentation.

For ablation of alveolar bone, Solea was used on the Dentin Setting: 1.00 mm spot size, 75 µs pulse duration, 100% mist and 50%–100% variable speed foot pedal. This setting was used to ablate alveolar bone to establish the biologic width while exposing sufficient tooth structure coronal to the alveolus for proper restoration. The spot size was switched 0.25 mm for more precise control on the bone adjacent to the tooth structure. Note the good blood perfusion of the alveolar bone. The red arrow shown after bone ablation prior to suturing (Fig. 10) shows the bone level relative to a reference point near the cementoenamel junction. The flap is shown prior to approximation and suturing (Fig. 11). The level of the alveolar bone was checked radiographically prior to closure with the bone level indicated with red arrows (Fig. 12a). The flap was closed and sutured with four interrupted 3.0 silk sutures. The distal buccal of #14 can be seen with improved gingival tissue position immediately after suturing, as indicated by a red arrow at the reference point (Fig. 12b).

The patient was prescribed chlorhexidine 0.12% rinse, twice per day for ten days and 500 mg of azithromycin on day one, and 250 mg on days two through five. The patient returned for suture removal nine days post operatively, healing well, with no evidence of infection. The patient returned nine days post-operatively, healing well without evidence of infection. The patient did not return until five months later. Ridge and gingiva around #s 16 and 14 were healthy (Figs. 13a and 13b) with normal periodontal probings.

_Case 3: Removal of benign oral lesion

The third case is a healthy 76-year-old male patient, presenting with an uncomfortable oral lesion. General dentists routinely encounter these types of cases. The patient had a fibroma-like lesion on the right lateral border of the tongue. The lesion was 5 mm x 5 mm x 3 mm (Fig. 14).

It was ulcerated (de-epithelialized), which was likely the cause of his discomfort. His regular dentist was out of town, and I was seeing that dentist's emergency patients. I gave the patient three options: seeing an oral surgeon for evaluation and possible excision, reevaluation in a week by his regular dentist, or for me to remove the lesion with Solea that day. The patient chose removal by Solea that day. First, topical anaesthetic was applied (TAC 20 comprised of lidocaine 20%, tetracaine 4% and Phenylephrine 2%). The lesion was excised using Solea on the Soft Tissue Setting: 0.25 mm spot size, 60 µs pulse duration, 1% mist and 40%–80% variable speed foot pedal. This left a clean, blood free surgical site (Fig. 15).

The specimen was preserved in formalin and sent to a pathology lab. After excision, although there was no bleeding, I briefly lased the surgical site with Solea using the Soft Tissue Setting: 1.00 mm spot size, 20 µs pulse duration, no mist and 10%–30% variable speed, to form a "laser bandage" by lightly cauterizing the surgical site (Fig. 15). The patient reported no discomfort either during the procedure or postoperatively. The pathology report stated that the lesion consisted of fibrovascular connective tissue with fibrinoid necrosis and acute inflammation. The patient

Fig. 14_Pre-operative 5 mm x 5 mm x 3 mm lesion right lateral tongue.
Fig. 15_Immediate post-operative.
Fig. 16_Five-day follow up, healing well.

returned five days later for a routine postoperative visit. The surgical site had healed extremely well (Fig. 16).

_Conclusion

These cases show that Solea, a 9.3 µm CO_2 laser, is a technology that dramatically improves the dental experience for both the practitioner and patient. The speed and precision of the laser allows me to be more efficient while achieving better clinical outcomes. Although local anaesthetic was used in one of the cases discussed in this paper, I actually perform 93 % of my hard and soft tissue procedures without anaesthesia. Most crown and bridge procedures and more extensive periodontal surgeries (like Case 3 above) typically require anaesthesia, but these are the only exceptions. In soft tissue applications, there is minimal bleeding which maintains a clean surgical site and the reduced need for sutures. Because of this, I take on procedures that I would have referred out prior to having Solea and I am able to complete these procedures approximately 50 % more quickly and with more precision than I could achieve with traditional tools. For my patients, the experience during surgery is dramatically improved and after the procedure they have much less post-operative discomfort. According to feedback from my patients, they love not having to get an injection, hear the "drill", or feel the vibrations. Patients love that I can work in multiple quadrants during the same visit, reducing their number of appointments, and so do I. Patients are amazed by the experience and are surprised when they find out that this technology is not more common among my peers. I am grateful to be able to practice in a time where such incredible instruments are available._

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Kurz & bündig

Im vorliegenden Artikel stellt der Autor mehrere Fallberichte vor, welche die Wirkungsweise eines neuartigen CO_2-Lasers mit einer Wellenlänge von 9.3 µm illustrieren. Während CO_2-Laser mit einer Wellenlänge von 10.6 µm bisher vor allem bei der Behandlung im Weichgewebebereich eingesetzt wurden, zeigen die Fallberichte Behandlungsoptionen des CO_2-Lasers für Weich-, Hart- und Knochengewebe auf. Der hier genutzte CO_2-Laser (Solea, Convergent Dental Inc.) kombiniert diese besondere Wellenlänge mit computergesteuerten Motoren. Diese bewegen kleine Spiegel innerhalb des Handstücks, um den ursprünglich 0,25 mm breiten Laserstrahl auf bis zu 1,25 mm zu vergrößern. So können für jede Behandlungssituation individuelle Modi eingestellt werden. Abhängig vom zu behandelnden Gewebe kann der Laserstrahl somit spezifisch angepasst werden.

In insgesamt drei Fallberichten beschreibt der Autor die Anwendung des CO_2-Lasers bei einer defekten Amalgamfüllung, einer chirurgischen Kronenverlängerung sowie der Entfernung einer gutartigen Läsion. Im Verlauf der Fallberichte wird deutlich, dass durch den Einsatz moderner Lasertechnologie, hier in Kombination mit minimaler lokaler Betäubung, der Patientenkomfort sowohl während der Behandlung als auch postoperativ erheblich verbessert und die Behandlungsdauer sowie die Anzahl der notwendigen Sitzungen deutlich reduziert wird. Weitere Vorteile sind geringere Blutungsneigung, die ein übersichtliches Operationsfeld und damit einen reduzierten Bedarf für durch Nähte unterstütze Wundheilung nach sich ziehen.