Photo-biomodulation with a 970 nm wavelength laser

A clinical case report

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Case outline

A 16-year-old male patient presented with Class II Division I malocclusion with a buccally positioned maxillary left canine which was transposed with a short-rooted maxillary left first premolar (Figs. 1a & b). The orthodontic treatment plan involved extraction of the left and right first premolars and the retained maxillary left primary canine to reduce the 5.5 mm overjet and improve alignment of the maxillary and mandibular dentition.

Maxillary and mandibular metal fixed appliances with 0.022 x 0.028 in. slot brackets were bonded, and initial levelling and aligning were performed. Sliding mechanics were applied during initial space closure. However, during the end of the space closure stage, the last 1.5 mm of space between the maxillary left canine and the maxillary left lateral incisor was found to be stationary and difficult to close up (Fig. 2). Both power chain and loop mechanics on TMA archwire were applied for a year, yet the space between these teeth remained.



Fig. 1a: Initial clinical situation.

Laser intervention

Currently, diode laser wavelengths range from 445 nm (visible blue colour) to 980 nm (near infrared). Owing to the optical properties of these wavelengths, they are mainly absorbed by haemoglobin and melanin. Variations in the absorption coefficients of these two chromophores determine the penetration depth of the wavelength into the dental alveolar bone. Since the blue (445 nm) and red (660 nm) wavelengths are much better absorbed by melanin and haemoglobin, absorption is mainly on the surface of the mucosa. There is comparatively less absorption into thicker alveolar bone than with the near-infrared wavelength.

The use of low-level or low-intensity laser therapy in photo-biomodulation (PBM) is known for the modulation of the host inflammatory response. Cytochrome C in mitochondria is the primary photoreceptor (chromophore) for the blue, red and infrared light spectrum. The non-thermal photochemical interaction has direct effects on mitochon-





Fig. 1b: Initial radiograph. **Fig. 2:** Radiograph showing the last 1.5 mm of space between the maxillary left canine and the maxillary left lateral incisor.

drial activation in proliferation, ATP production, action potential in excitable cells, priming of lymphocytes, and production of lymphokines, cytokines and neurotransmitters. The NADPH oxidase activation generates reactive oxygen species which generate nitric oxide for vaso-dilation. The chemical mediators of the inflammatory process, such as interleukin-10, interleukin-4 and superoxide dismutase, are increased while the pro-inflammatory factors, such as tumour necrosis factor alpha (pain-related) and interferon gamma, are decreased. The result of these effects on oedema allows for a smaller volume of oedema, preventing cell death and allowing better regeneration of nerve cells. The effects of PBM on bone stimulate the proliferation, differentiation and synthesis of osteoblasts; increase the activity of alkaline phosphatase; increase cell adhesion; increase bone remodelling and turnover; and increase angiogenesis. PBM also induces cells to produce fibroblast growth factor to stimulate wound healing.

Laser and wavelength of choice

The SiroLaser Blue diode laser (Dentsply Sirona) consists of 445, 660 and 970 nm wavelengths. The 970 nm wavelength was chosen for the power setting available in this unit. This wavelength was applied to activate the bone cells and thus aimed at accelerating the tooth movement.

The diode laser used for treating this case was set to the following parameters:
- Wavelength: 970 nm
- Mode of operation: continuous wave
- Power: 200 mW
- Fibre size: 8 mm multi-tip
- Fluence: 0.4 J/cm^2
- Exposure time: 20 seconds
- Dose per point: 8 J/cm^2

Treatment procedure and irradiation technique

The areas of irradiation were the buccal and palatal aspects of the residual interradicular space and apices of the maxillary left canine and maxillary left lateral incisor. The multi-tip was placed with light pressure in contact with the mucosa during irradiation. The procedure was repeated at a two-week interval.

Result and discussion

The space was found to be closed after one month of the first diode laser application (Fig. 3), and the case was debonded and retained with a maxillary fixed lingual retainer (Fig. 4). There are many variations in wavelength, parameter and method of irradiation for PBM in acceleration of orthodontic tooth movement. Tissue composition and age of the patient also affect the outcome of the PBM therapy.





Fig. 3: Clinical situation one month after the first diode laser application. **Fig. 4:** Occlusal view: the case was debonded and retained with a maxillary fixed lingual retainer.

Conclusion

The use of the 970 nm diode wavelength was able to assist in difficult orthodontic movement of the maxillary left canine and left lateral incisor.

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