

COMPARING THE 810NM DIODE LASER WITH CONVENTIONAL SURGERY IN ORTHODONTIC SOFT TISSUE PROCEDURES

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Conflict of Interest: None declared

SUMMARY

Aim: To compare the use of the 810nm diode laser with conventional surgery in the management of soft tissue mucogingival problems associated with orthodontic treatment.

Methods: Orthodontic patients requiring different soft tissue surgical procedures were randomly assigned to receive conventional surgery or soft tissue diode laser, (wavelength 810 nm).

Main outcome measures: Parameters documented include the type of anaesthesia used, intra and post operative pain, bleeding, the use of scalpel and sutures. The chi-squared test was used to test for significance at 95% confidence level. Probability values (p-values) less than 0.05 were regarded as significant.

Results: Only 2(16.7%) of the procedures carried out with the soft tissue laser required infiltration anaesthesia compared to 10 (90.9%) with conventional surgery and this was significant (P<0.001). Post operative pain was significantly reduced in all cases treated with the diode laser (P<0.001). There was also a significant difference (P<0.05) in post operative bleeding in all cases treated with the diode laser. No sutures were used in all soft tissue cases managed with the diode laser and this was significant (P<0.001). There was no statistically significant difference in treatment time in the use of the laser compared with conventional surgery.

Conclusion: Orthodontic patients treated with the diode laser required less infiltration anaesthesia, had reduced bleeding during and after surgery, rapid postoperative haemostasis, elimination of the need for sutures and an improved postoperative comfort and healing.

Keywords: Diode laser, conventional surgery, orthodontics, Laser therapy, laser surgery

INTRODUCTION

The laser is a relatively new and modern technology developed by Maiman in 1960.¹ However, it was first successfully used in the oral cavity in 1977 with subsequent improvements and innovations over time.¹⁻³

These included the development of the carbon dioxide (CO₂) laser with a wavelength of 10,600nm for soft tissue surgery in the 1980's^{3,4}, the 3W neodymium-doped yttrium aluminium garnet (Nd:YAG) with a wavelength of 1,064nm in 1989^{3,5} and the diode laser with a wavelength ranging from 800nm to 980nm.⁶ Others include the Erbium-chromium-doped yttrium scandium gallium garnet (Er,Cr:YSGG) with a wavelength of 2,780nm and the Erbium-doped yttrium aluminium garnet (Er:YAG) with a wavelength of 2,940nm.^{3,7}

Some laser wavelengths work on both hard and soft tissues (2,780 nm, 2,940 nm)³ while other lasers, such as the 810 nm diode work on only soft tissues and have a very good surgical and haemostatic action on soft tissues following maxillary vestibular frenectomies, gingivectomies and recontouring of gingival overgrowth, surgical exposure of buccally and palatally placed teeth and operculectomies.^{1,6,7-17} Also, the soft tissue diode lasers have an excellent incision performance with a cutting depth of 2-6mm^{9,10} and have an added advantage over conventional surgery in that there is a sealing of small blood and lymphatic vessels resulting in haemostasis and reduced post-operative oedema. Target tissues are also disinfected as a result of local heating and production of an eschar layer and a decreased amount of scarring due to decreased post-operative tissue shrinkage.^{9,10} Consequently, the use of sutures is eliminated.^{4,14,17}

An orthodontic appliance in the mouth impedes proper oral hygiene maintenance resulting in the accumulation of plaque which may result in inflammation of the periodontal tissues.^{6,8} This may result in gingival enlargement especially in those patients with poor oral hygiene^{6,8}, which may subsequently require aesthetic recontouring or gingivectomy to correct. Other procedures like maxillary frenectomy, operculectomy and surgical exposure of impacted teeth require various forms of soft tissue surgery in orthodontics.^{1,6,8,9,12,19}

Previously conventional surgical procedures were performed using a scalpel under local anaesthesia for these procedures.¹⁹ However, the use of laser has become more popular with studies demonstrating the use of the CO₂, Nd:YAG^{5-6,13,18,19} and diode lasers^{8-10,19-21} in orthodontics.

These studies demonstrated that the laser may be used to expose unerupted teeth; reposition the maxillary frenum, aesthetic recontouring of hyperplastic gingivae and removal of granulomatous gingivae as a result of orthodontic movement. The use of the diode laser demonstrated excellent clinical benefits which include coagulation of blood vessels and precise control of the amount of tissue removed.^{10,11,13,14,19-21} This study aimed to compare lasers in the management of soft tissue surgical procedures with conventional surgery amongst patients undergoing orthodontic treatment.

METHODS

Stratified random sampling was used on orthodontic patients who were subdivided into two groups according to the type of treatment. Systematic random sampling was now carried out on each group and every 'n'th name included for each group (n being a random number taken from a statistical table). Group 1 was treated with soft tissue diode laser, (wavelength 810 nm); and Group 2 received conventional surgery.

The same Orthodontist (INI) performed the laser procedures in the orthodontic clinic, while the surgical procedures were performed by the same surgeon (BEE) in the oral surgery clinic. Ethical approval was obtained from the Ethics and Protocol Committee of the University of Benin Teaching Hospital, and written informed consent was also obtained from the patients.

Inclusion criteria: Healthy orthodontic patients currently wearing a fixed appliance; orthodontic patients with overgrown gingivae secondary to fixed appliance therapy; orthodontic patients with abnormal frenal attachment causing malocclusion; and orthodontic patients with impacted teeth requiring surgical exposure.

Patients with the following conditions were excluded from the study: Non orthodontic patients; orthodontic patients with poor oral hygiene; orthodontic patients with mucogingival infection; orthodontic patients with trismus and limitation of mouth opening; and orthodontic patients with any medical condition affecting wound healing.

All the patients with palatally impacted teeth underwent an initial surgical procedure which involved raising a flap, removal of the overlying bone with a

round surgical bur, bonding of an orthodontic bracket and replacement of the flap. These patients with the palatally impacted teeth were now randomly assigned into two groups and treated 2 months later. Group 1 consisted of patients with soft tissue exposure of the bonded bracket using the diode laser. Group 2 consisted of patients with soft tissue exposure of the bonded bracket with conventional surgery.

Parameters documented include the types of anaesthesia used, intra and post operative bleeding, pain and discomfort and the use of a scalpel and sutures.

Intra and post operative bleeding were determined by the WHO bleeding scale.²²

Grade 0 no bleeding;

Grade 1 petechial bleeding;

Grade 2, mild blood loss (clinically significant);

Grade 3 gross blood loss, requires transfusion;

Grade 4 debilitating blood loss, retinal or cerebral associated with fatality.

Pain was measured using the Visual Analogue Scale (VAS) which is a horizontal line 10cm in length anchored by word descriptors at each point and classified as follows:

Score 0-1cm - no pain or distress

Score 2-3cm - annoying

Score 4-5cm - uncomfortable

Score 6-7cm - dreadful

Score 8-9cm - horrible

Score 10cm - agonizing or unbearable distress

Patients were asked to rate their pain experience and allocate a score before (VAS1); and after taking pain killers (VAS2) on the visual analogue scale. The difference (VAS1) – (VAS2) would be regarded as an indicator of the analgesic effect. The surgeon used the same type of surgical blade (carbon, no 15C) and black silk sutures for all cases requiring suturing.

Statistical analysis was performed with the statistical package for social sciences soft ware (SPSS) version 15.0. The chi-squared test was used for significance at 95% confidence level. Probability values (p-values) less than 0.05 were regarded as significant.

RESULTS

Twenty-three orthodontic patients (17 females and 6 males of age range 10-30 years) were examined. Eleven (47.8%) were treated by conventional surgery and 12 (52.2%) with soft tissue diode laser. Soft tissue procedures included maxillary vestibular frenectomies, gingivectomy, recontouring of gingival overgrowth, surgical exposure of buccally and palatally placed teeth and operculectomies.

There was no significant association between both treatment types and age ($P>0.05$). There was a significant association, ($P<0.001$) between the type of anaesthesia used and the treatment type. Infiltration anaesthesia was used in all 11 (100%) patients for conventional surgery.

Topical anaesthesia was used in 10 (90.1%) of the patients for soft tissue diode laser. All 12 (100%) procedures carried out with the soft tissue diode laser were graded 0 on the WHO bleeding scale, compared with all 11 (100%) procedures carried out by conventional surgery with a grade 1 on the WHO bleeding scale ($P<0.001$).

Table 1 shows the frequency distribution of soft tissue procedures with surgical exposure of unerupted teeth with the highest frequency of 11 (47.8%) and aesthetic recontouring and operculectomy having the lowest frequency of 2 (8.7%) respectively.

Table 1 Frequency distribution of soft tissue procedures

| Soft Tissue Procedure | Treatment type | | Total |
|------------------------|----------------|-------------------|----------------|
| | Conv. Surgery | Soft tissue laser | |
| | n (%) | n (%) | n (%) |
| Aesthetic Recontouring | 1(9.1) | 1(8.3) | 2(8.7) |
| Gingivectomy | 2(18.2) | 2(16.7) | 4(17.4) |
| Maxillary Frenectomy | 2(18.2) | 2(16.7) | 4(17.4) |
| Operculectomy | 1(9.1) | 1(8.3) | 2(8.7) |
| Surgical exposure | 5(45.6) | 6(50) | 11(47.8) |
| Total | 11(100) | 12(100) | 23(100) |

There was significant association between treatment type and post operative pain ($P<0.001$). Ten (83.3%) patients treated with the soft tissue diode recorded a VAS1 and VAS2 score of 0 respectively on the visual analogue scale post operatively, while 3 (27.2%) of the conventional surgery procedures recorded a VAS1 score of 8 and VAS2 score of 0 respectively on the visual analogue scale post operatively.

There was a significant difference, ($P<0.001$), in the use of surgical blade between procedures with laser surgery and those with conventional surgery. None of the laser procedures required the use of incisions with a surgical blade, while 11 (100%) of the conventional surgical procedures required incision.

A significant difference, ($p<0.001$), was observed in suturing between procedures with laser surgery and conventional surgery. None of the laser procedures

required suturing while 8 (72.7%) of the conventional surgical procedures required suturing. There was no statistically significant difference between the time it took to complete either procedure or the treatment type. However, the largest number of procedures recorded the shortest treatment time of 5 minutes with the soft tissue diode laser. When compared with conventional surgical procedures, the longest treatment time was recorded with 120 minutes.

Table 2 Comparative analysis of treatment type and duration of procedure

| Duration of procedure (in minutes) | Treatment type | | Total |
|------------------------------------|----------------------|-------------------|----------------|
| | Conventional surgery | Soft tissue laser | |
| | n % | n % | n % |
| 5 | 1(16.6) | 5(83.3) | 6(100) |
| 7 | 0(0) | 1(100) | 1(100) |
| 10 | 1(33.3) | 2(66.7) | 3(100) |
| 15 | 1(50) | 1(50) | 2(100) |
| 20 | 0(0) | 1(100) | 1(100) |
| 30 | 3(100) | 0(0) | 3(100) |
| 35 | 0(0) | 1(100) | 1(100) |
| 45 | 1(100) | 0(0) | 1(100) |
| 52 | 1(100) | 0(0) | 1(100) |
| 55 | 0(0) | 1(100) | 1(100) |
| 70 | 1(100) | 0(0) | 1(100) |
| 75 | 1(100) | 0(0) | 1(100) |
| 120 | 1(100) | 0(0) | 1(100) |
| Total | 11(47.8) | 12(52.2) | 23(100) |

DISCUSSION

Various studies have been carried out which compared conventional surgery and the use of lasers.^{2,4,18,19} Some studies have compared the use of different types of lasers in different specialties of Dentistry.¹⁻⁸ However, there appears to be no studies comparing the use of the soft tissue diode laser and conventional surgery in the management of soft tissue procedures in orthodontics in our environment.

In this study, of all the subjects treated with the diode laser, 90.1% of the procedures were performed without infiltration anaesthesia compared to 9.1% of procedures by conventional surgery and this was significant ($P<0.001$). Topical anaesthesia was used for almost all the diode laser procedures. When compared with studies by Panagiotis¹¹ and Fornaini et al¹⁹ all the laser procedures performed in their study were without infiltration anaesthesia or sutures. Only topical anaesthesia was needed.

This study demonstrates a significant difference, ($p < 0.001$), between the use of a scalpel in conventional surgery and the use of the diode laser as none of the subjects with the diode laser required a scalpel incision. Also it showed an advantage of the diode laser over conventional surgery as no suturing was required for procedures with the diode laser.

This compares favourably with studies by Vescovi et al¹⁸ which concluded that other laser types appear also to be a better alternative to the scalpel. Other studies by Stubinger et al¹⁴ demonstrated the effect of the laser for various surgical procedures in the oral cavity with excellent effects on the oral soft tissues. These included excellent intra operative and post operative bleeding and pain as a result of the excellent cutting and coagulation abilities of the laser¹⁰⁻¹⁸.

These studies¹⁰⁻¹⁸ also showed that the diode laser is a useful instrument in oral soft tissue surgery and an alternative to conventional electro surgery and the use of scalpel. Studies by Pirnat¹⁰ demonstrated the cutting ability of the soft tissue diode laser with a depth of 2-6mm into the tissues with the sealing of small blood and lymphatic vessels as a result of the heat generated thereby eliminating bleeding and oedema. However, another study¹⁷ indicated that scalpel repair was found to be equivalent or better than laser repair as a result of thermal damage to the tissues but also advocated the clinical use of the low level diode laser as an alternative to scalpel incision and suture repair.

This study shows the benefit of the soft tissue diode laser over conventional surgery during orthodontic treatment, which includes a reduced intra operative and post operative bleeding and a reduced operating time. However, there was no statistically significant difference between the duration of time it took to complete either procedure or the treatment type.

Although the soft tissue diode laser recorded the shortest treatment time of 5 minutes for most procedures, when compared with conventional surgical procedures, the longest treatment time was recorded in 120 minutes. This compares favourably with studies by Pick et al⁴, Panagiotis et al¹¹ and Fornaini et al¹⁹ where the operating time with the use of the laser was also reduced as a result of reduced bleeding during surgery and rapid post operative haemostasis. Other studies^{2,10,12} also recorded less bleeding with the use of the laser.

This study shows a significant association between treatment type and post operative pain ($P < 0.001$). The soft tissue diode laser demonstrated a high cutting ability with coagulation and thermal necrosis of the

surrounding tissues with minimal post operative pain. This is similar to the findings in other studies^{4,10,11,14} where the laser was used for frenectomies, ablation of lesions, incisional and excisional biopsies, gingivectomies, gingivoplasties, soft tissue tuberosity reductions, operculectomies, coagulation of graft donor sites and certain crown lengthening procedures.

Studies by Antenucci²³ concluded that the use of the laser in soft tissue management maximized the health of the oral tissues in a minimally invasive manner. Other studies¹¹ indicated a reduced intra operative and post operative pain with the use of the soft tissue laser. Also reduction of pain, a faster healing without the use of sutures and haemostasis were demonstrated in the clinical use of the soft tissue diode laser in some studies.^{4,14-16}

In conclusion, the results of this study show that the diode laser is a useful instrument with a greater advantage over conventional surgery in the management of soft tissue procedures.

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