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CLINICAL EVALUATION OF SOFT TISSUE HEALING USING DIODE LASER VERSUS CONVENTIONAL SCALPEL AFTER MICRO-ENDODONTIC SURGERY

Abstract

Micro-endodontic surgery attempt to minimize trauma and enhance esthetics soft tissue surgical results. Wound healing monitoring is performed for early identification of signs and symptoms related to surgical complications. The aim of this study was to compare surgical wound healing of soft tissue flap after using conventional scalpel and diode laser in micro-endodontic surgery. Methodology: This study was carried out as a randomized controlled clinical trial after taking approval of BAU institutional review board. Fourteen healthy patients were indicated for root end surgery; full mucoperiosteal tissue flap incision was done by using Bard-Parker Blades (Group I) and (Group II) Diode Laser with a wavelength of 940 nm set at a power of 1.5 W. Follow-up assessment scale was used at the day of surgery (baseline) and days 1, 3, 7 and 30. After surgery to monitor the following clinical parameters including pain, swelling, bleeding and wound healing. Result: The clinical parameters investigated were statically analyzed and showed that there was no statistically significant difference between the laser and scalpel groups during all follow-up days ($P > 0.05$). Conclusion: Both Diode Laser and Conventional Scalpel yield same effect on wound healing. Moreover, careful training in oral hygiene, combined with a valid surgical technique is essential to obtain the best result of soft tissue healing after micro-endodontic surgery.

Keywords

Diode laser, Micro-endodontic surgery, pain, bleeding, swelling, wound healing.

1. INTRODUCTION

Endodontic surgery is a facet of comprehensive root canal treatment, which can manage problems that cannot be eliminated by nonsurgical techniques (Kim and Kratchman, 2006). The aim of surgical endodontic treatment is to remove any associated extra-radicular infection and foreign bodies including the removal of soft tissue lesions such as persistent apical granulomas and cysts. (Ananad et al., 2015). The root canal system must then be sealed to block the escape of any persistent intra-radicular microbes and prevent the ingress of potential nutrients from the periapical tissues (Eliyas et al., 2014).

Steel scalpel and laser systems are widely utilized as effective tools in a soft-tissue surgical procedure (Christensen, 2008). A scalpel is commonly used because of its accuracy and minimal damage to tissues. Scalpels do not provide good hemostasis, which is important in highly perfused tissues such as in the oral cavity (D'Arcangelo et al., 2007).

However, steel scalpel and laser are different from the standpoints of hemostasis, healing time, cost of instruments, the width of the cut, anesthetic required and disagreeable characteristics, such as smoke production, the odor of burning flesh and undesirable taste. Lasers emit a precise beam of concentrated light energy. Because specific wavelengths provide great precision, minimizing the potential risk of lateral tissue damage (Mills et al. 2018).

Adequate management of soft tissue during endodontic surgery should be considered mandatory to obtain satisfactory healing, without impairing esthetics and function (Velvart et al., 2005).

Soft tissue healing is the replacement of the dead or damaged tissue by cells derived from the parenchymal cells or connective elements of the injured tissue. The healing involves two distinct processes of regeneration and repair (Newman et al., 2009). In an ideal situation, the post-surgical healing will be such as to restore stability, form, and function to the tissue. In oral soft tissue surgery, where appropriate, the aesthetics of the tissue will be maintained or, as is often the desired outcome, improved with regard to fixed restorations (Parker, 2007). D'Arcangelo et al., 2007, reported that diode lasers tend to produce more changes with regard to the degree of inflammatory response and delay in tissue organization than a scalpel but only at the initial stage. Luomanen 1987 compared incisions made by scalpel and laser and reported a delay in capillary proliferation at laser-treated sites during the early healing phase. In addition, other studies have reported a denser inflammatory cell infiltrate in laser wounds compared to scalpel induced wounds (Schaffer et al., 1997).

2. AIM OF THIS STUDY

The aim of this study was to evaluate clinically the soft tissue healing after using diode Laser and conventional scalpel in the micro endodontic surgery.

3. MATERIALS AND METHODS

After the approval of the ethical committee (IRB number: 2018H-0061-D-M-0261). This study was carried out as a randomized controlled clinical Trial. Fourteen healthy patients (N=14) had teeth indicated to root end surgery.

Inclusion criteria: Fourteen healthy patients (N=14) with age range between 18-45 years who had anterior teeth indicated to root end surgery, divided into two groups according to the type of incision: Group I (n=7) scalpel incision, Group II (n=7) laser incision.

Patients with systemic disease(s) that affect the healing ability like uncontrolled diabetes mellitus, anemia and thyrotoxicosis were excluded from the study, as well as patients with bad oral hygiene, advanced periodontal disease and smokers.

The pre-operative assessment includes a full medical and dental history, extra-oral and intra-oral examinations and periapical radiographs and CBCT (CS 9000 Carestream Dental LLC, Atlanta, GA, United States).

All clinical procedures were performed according to the same guidelines and principles for root-end surgery. All surgical procedures were performed using a surgical operating microscope (Leica M320, Germany). Patients were locally anesthetized with 2% Lidocaine 1:80,000 adrenaline (Septodont, Brampton, ON, Canada).

Full mucoperiosteal rectangular flap design was used in this study. For Soft tissue incision was done using Bard-Parker blade No.15C in group I. Diode Laser in group II: with a wavelength of 940 nm set at a power of 1.5 W according to manufacture instructions (SiroLaser, Dentsply Sirona, Germany).

A special micro-saw OT7S-4 piezo surgery tip (Mectron, Carasco, Italy) was used after determined exact location of the apex, the-cortical bone removal at the apical side of the diseased root with copious water spray under low magnification (6.5x to 10x). The apex was cut for 3 mm from the root apical part using the same tip. Methylene blue (1%) was used to stain the periodontal ligament and apical anatomy to improve visualization. Once the lesion and the root tip were exposed, mini endodontic curettes were used to completely remove the lesion tissue (Ananad et al., 2015). The root end cavity was prepared at 3 mm depth along the long axis of the root, using diamond-coated retro tips, EN1(Abella et al., 2014). Then sealed with a homogenous mixture of MTA. The homogenous mixture of MTA was applied by MTA applicator (MAP One system, Dentsply, Maillefer, Switzerland) in the root end then condensed with an appropriate plugger. After removing the excess of the MTA, Preapical x-ray was taken to be sure no needed for any adjustments.

The flap was gently eased back into place and gentle pressure was applied using saline-moistened gauze to aid close approximation for flap re-attachment, with 5.0 silk interrupted sutures.

3.1. Follow up Phase

The postoperative evaluation was made clinically at 1st, 3rd, 7th and 1 month postoperative days to record the pain, bleeding swelling, and wound healing in comparison to bassline data.

3.2. Pain Assessment

The patients were asked to rate their pain intensity based on detailed description of pain scale (Farshid et al., 2015) as follows: 0 = No pain, 1-3 = There is a pain, but feel comfortable (Very low and mild pain), 3-5 = Pain gets attention and may affect the daily performance. 5-7 = Annoying pain; but have the ability to focus on other issues, 7-9 = Severe pain that can prohibit the work. Feel discomfort even in rest, 10 = Worst pain. Score the chosen as 0, 2, 4, 6, 8, 10, counting left to right, so '0' = 'no pain' and '10' = 'very much pain'.

3.3. Bleeding Assessment

Intra and postoperative bleeding were determined according to the WHO bleeding scale (Webert et al., 2006) as 0 = No bleeding, 1 = Petechial bleeding, 2 = Mild blood loss, clinically significant, 3 = Gross blood loss, requires transfusion, 4 = Debilitating blood loss, retinal or cerebral associated with fatality.

3.4. Swelling Assessment

The following scoring system (Peñarrocha-Diago et al., 2012) was used: 0 = absence of swelling; 1-3 = mild swelling, located within the mouth in the surgical zone; 4-6 = moderate swelling, located within the mouth and with mild swelling also outside the mouth; 7-9 = intense swelling outside the mouth in the surgical zone; 10 = very intense extra oral swelling extending beyond the surgical zone. Score the chosen as 0, 2, 5, 8, 10, counting left to right, so '0' = 'no swelling' and '10' = 'very intense extraoral swelling'.

3.5. Wound Healing Assessment (Gonshor, 2002)

Healing Index 1: (Very poor) Tissue color: 50 % of gingiva red. Response to palpation: bleeding. Granulation tissue: present. Incision margin: not epithelialized, with loss of epithelium beyond incision margin. Suppuration present. Healing Index 2: (Poor) Tissue color: 50 % of gingiva red. Response to palpation: bleeding. Granulation tissue: present. Incision margin: not epithelialized, with connective tissue exposed. Healing Index 3: (Good) Tissue color: 25 and 50 % of gingiva red. Response to palpation: no bleeding. Granulation tissue: none. Incision margin: no connective tissue exposed. Healing Index 4: (Very good) Tissue color: 25 % of gingiva red. Response to palpation: no bleeding. Granulation tissue: none. Incision margin: no connective tissue exposed. Healing Index 5: (Excellent) Tissue color: all tissues pink. Response to palpation: no bleeding. Granulation tissue: none. Incision margin: no connective tissue exposed.

3.6. Statistical Analysis of the Data

Data were analyzed using IBM SPSS software package version 24.0 Quantitative data were described using number and percent. Qualitative data were described using range, minimum and maximum, mean, standard deviation, and median. Confidence level was set to be 95%.

4. RESULT

Descriptive statistics were generated to detail the distribution of the pain, bleeding, swelling and wound healing at baseline, day1, day3, day7 day30. Data were not normally distributed; therefore minimum and maximum values were generated.

Table 1: Mean and standard deviation comparing the pain, bleeding, swelling and wound healing during days of follow up for scalpel group.

N=7	SP	SB	SS	SH
d0	2.28±0.75	1.00±0.577	2.57±3.77	*
d1	1.42±1.51	0.43±0.787	5.14±3.18	2.71±0.488
d3	0.85±1.06	0.14±0.378	3.00±2.64	3.43±0.787
d7	0.28±0.75	0.00±0.000	0.00±0.00 0	3.71±0.488
d30	0.00±0.000	0.00±0.000	0.00±0.00 0	5.00±0.000
<i>p</i> ^a	0.000	0.003	0.001	0.000

SP: Scalpel Group Pain, SB: Scalpel Group Bleeding, SS: Scalpel Group Swelling, SH: Scalpel Group Wound Healing, M: Mean, SD: Standard deviation, N: Cases Number, d: Day, P: Asymp. Sig., a. Friedman Test.

There was a statistically significant difference ($p < 0.05$) in pain feeling against time. Pain levels decreased gradually among days of the follow-up (Table 1). At baseline, it showed the greatest pain level, and then day 1 showed fewer levels of pain. Day 3 reflected an important decrease in pain. Day 7 even showed more decrease in pain. Finally, day 30 reflected no pain in all patients among days of follow up. There was a statistically significant difference ($p < 0.05$) in bleeding occurred among time (Table 1). On baseline, bleeding showed the greatest level of bleeding. Then day 1 showed less bleeding. Day 3 reflected an important decrease in bleeding. Finally, on day 7 and day 30, there was no bleeding in all patients in the scalpel group.

There was a statistically significant difference ($p < 0.05$) in swelling occurred among time (Table 1). On baseline, was showed low a level of swelling. But day 1 reflected the greatest levels compared to other days. At day 3 swelling started decreasing. Then, the levels of swelling continued decreasing till reaching day 7 and day 30 where no swelling in all the patients was indicated.

There was a statistically significant difference ($p < 0.05$) in wound healing among time. Wound healing among days was indicated as the following (Table 1). On day 1, wound healing was started. Day 3 reflected a greater degree of wound healing. Then day 7 showed little kind of wound healing. Finally, day 30 reflected the best wound healing in all the patients of scalpel group.

Table 2: Mean and standard deviation comparing the pain, bleeding, swelling and wound healing during days of follow up for the laser group.

	LP	LB	LS	LH
d0	2.57±0.97	0.86±0.900	1.71±2.92	*
d1	1.42±1.51	0.29±0.756	5.85±2.26	2.71±0.756
d3	0.28±0.75	0.14±0.378	3.00±2.64	3.29±0.756
d7	0.85±1.57	0.29±0.756	1.42±2.43	3.43±0.787
d30	0.28±0.75	0.00±0.000	0.00±	4.57±0.535
<i>p</i> ^a	0.001	0.19	0.001	0.001

SP: Scalpel Group Pain, SB: Scalpel Group Bleeding, SS: Scalpel Group Swelling, SH: Scalpel Group Wound Healing, M: Mean, SD: Standard deviation, N: Cases Number, d: Day, P: Asymp. Sig., a. Friedman Test.

There was a statistically significant difference ($p < 0.05$) in pain feeling among time (Table 2). The pain levels decreased through days of follow up. At baseline, the greatest pain level was indicated. Then pain decreased in day1 which reflected lower levels. Day3 showed an important decrease in pain. Then on day 7, little increase was indicated. Finally, day 30 showed the lowest pain.

There was a statistically significant difference ($p < 0.05$) in bleeding among time (Table 2). The bleeding occurred on days of the follow up as follows: On baseline, the greatest bleeding level was shown. Then bleeding decreased on day 1 which reflected low levels. Day 3 showed an important decrease in bleeding. On day 7, like day 3 showed low levels of bleeding. Finally, day 30 showed no bleeding in all patients among days of follow up.

There was a statistically significant difference ($p < 0.05$) in swelling occurred among time. (Table 2) Swelling among days of the follow up was presented as baseline showed a low level of swelling. Day 1 showed the greatest level of swelling compared to other days. Day 3 showed a level of swelling. Day 7 showed a good decrease in swelling. Finally, day 30 showed no swelling in all the patients among days of follow up.

There was a statistically significant difference ($p < 0.05$) in wound healing among time (Table 2). Wound healing started gradually among the days of follow up: On day 1, was started healing. Day 3 showed a greater degree of wound healing. Day 7 showed little difference in wound healing compared to day 3. Finally, day 30 showed the greatest wound healing level.

All clinical variables (pain, bleeding, swelling, and wound healing) had no statistically significant difference ($p > 0.05$) between the laser group and scalpel group during all follow-up days.

Table 3: Test Statistics of the Compare the pain, bleeding, swelling, wound healing between the laser group and scalpel group on each day of the follow up (baseline, day 1, day 3, day 7, day 30)

	Z/P	S_d0 - L_d0	S_d1 - L_d1	S_d3 - L_d3	S_d7 - L_d7	S_d30 - L_d30
Pain	Z	-.828 ^b	-.966 ^c	-1.414 ^c	-.816 ^b	-1.000 ^b
	P	.408	.334	.157	.414	.317
Bleeding	Z	-.378 ^c	-.272 ^c	.000 ^d	-1.000 ^b	.000 ^d
	P	.705	.785	1.000	.317	1.000
Swelling	Z	-.816 ^c	-.333 ^b	-.184 ^b	-1.414 ^b	.000 ^d
	P	.414	.739	.854	.157	1.000
Wound healing	Z	-	.000 ^d	-.264 ^c	-.707 ^c	-1.732 ^c
	P	-	1.000	.792	.480	.083

S: Scalpel group, L: Laser group, P: Asymp. Sig. (2-tailed), a. Mann-Whitney Test, d0: Baseline, d1: Day1, d3: Day 3, d7: Day7, d30: Day30. b. Based on positive ranks, c. Based on negative ranks, d. The sum of the negative ranks equals the sum of the positive ranks.

5. DISCUSSION

Minimal trauma to both soft and hard tissues involved in peri-radicular surgical procedures require the raising of a mucoperiosteal flap and then revealing the root end(s) (Ankita Taltia, 2017). The flap-type used in this study was a rectangular flap. It was chosen because the rectangular flap is conservative and easy to perform, replace and suture, resulting in low morbidity. This flap has great mobility and permits to reach even very long roots. As well as every complete full thickness flap, it exposes the entire buccal cortical and can eventually lead to the treatment of endo-periodontal defects (Grandi, 2009).

Tissues were kept moist during surgery and the incisions were sufficiently extended to ensure that the retractor rests on bone and did not compress part of the flap with minimal trauma. This is in agreement to Lieblisch (2012) who reported that both reflected and unreflected tissue should be avoid tissue dryness during the entire procedure.

In present the study, both scalpel and laser groups had no significant difference in all clinical variables observed (pain, bleeding, swelling, and wound healing) during all follow-up days. Various surgical instruments used for cutting of oral mucosa have been compared for speed and ease of incision, the degree of hemostasis and charring, acute soft tissue injury, pain, swelling and wound healing rates (Sinha and Gallagher, 2003).

Pain started in both groups from day of surgery until day 7. There was no statistically significant difference between the two groups after one week. At day 3 pain was shown in scalpel group in three patients while disappeared in laser group patients except one patient. It was reported that pain is common but not always present after periapical surgeries, although it is still mild to moderate and short-term. It starts approximately a few hours after surgery, then it gradually decreases and ends after 1-3 days. (Mei et al., 2016) (Yao et al., 2017)

Bleeding in this study was not statistically significant different between the two groups. Petechial bleeding was noted in most of the patients in both groups from day of surgery until day 3. According to Yao et al., (2017), the mild bleeding is common for the first few hours after surgery but it may occur after hours or continue for 2-3 days due to suture loosening, flap instability or dehiscence.

In this study, postoperative swelling reached a high score at day 1 then gradually decreased at day 3 till day 7, except in two cases and this could be explained since the swelling is usually proportional to time and amount of tissue reflected. The swelling was more significant in the intra-sulcular incision (Wein, 1999). The results are compatible with Garcia et al. who stated that swelling peaked on the second postoperative day (Garcia and Marti, 2006). Likewise, Kvist and Reit reported that swelling was present in all patients and reached its maximum on the second postoperative day (Kvist T, 2000). This may be due to the accumulation of fluid exudates in the interstitial tissue spaces (Forsgren et al., 1985). In addition, other researchers concluded that the swelling was caused by the reflection of periosteum and not by making a relaxing incision (Al-Sandook et al., 2003), (Chang et al., 2002).

Wound healing in this study was not statistically different between the two groups after one week. Healing was good in both groups except in two cases (one in each group) that had delayed wound healing after one week. There are many factors that can interfere with one or more phases of the wound healing process, thereby causing improper or impaired tissue healing like operation time, amount of tissue reflected and postsurgical patient care (Boonsiriseth et al., 2014). In all flap surgeries, during the first week, the flap is still more susceptible to dislodgement since its adherence to the underlying hard tissues is only guaranteed by the consolidating blood clot (Sculean et al., 2004). Therefore, provided that adequate flap stabilization was obtained and maintained by the correct suturing technique, especially during the first days, spontaneous or function-related flap mobility disturbs clot arrangement and therefore induces bleeding from the incision lines and from the gingival margin, also delaying wound healing. For this reason, no pressure should be exerted on it at the first follow-up visit. Tissue healing is, therefore, faster if no mechanical trauma was applied to the flap, especially during the first week after surgery (Burkhardt and Lang, 2015).

In this study, all patients were monitored to have good oral hygiene (cleaning the wound site, avoid bad habits and follow the post-operative instructions). Plaque and food debris can be found on sutures and should be carefully removed with a cotton pellet to inspect all incision margins (Pippi, 2017). Postoperative oral hygiene is considered necessary for patients who have difficulty with oral cleaning due to surgical damage, as microflora harbored in the oral cavity may be composed of pathogens related to surgical site infection. Recently, oral health care has become recognized as essential to decrease postoperative complications (Shigeishi et al., 2015).

In the present study we observed there was a difference in hemostasis between laser and scalpel during the surgery, which revealed that the laser had better hemostasis affect during surgery. Other clinical variables showed no difference between the two groups. Romanos and Nentwig, (2018). Examined healing of oral soft tissue wounds following application of a 980-nm diode laser with (5W) and reported that clinical findings included sufficient hemostasis, precise incision margins, lack of swelling, pain or scar formation, and good wound healing. Moreover, Stubinger et al., (2006). Investigated the usefulness of the diode laser in 40 patients and concluded that postoperative clinical findings were excellent due to the sufficient cutting abilities, good coagulation effect and extremely small zone of thermal necrosis to the nearby tissues.

In this study, laser output power was (1.5W) and it was effective on the incision, with minimal thermal damage of the tissues. Jin et al. (2010) Reveal that the diode laser can be considered a good

incisional device for oral mucosa incisions; however, more tissue damage resulted from its use compared to that using a scalpel or an Er, Cr: YSGG laser. The diode laser was set at a wavelength of 810 nm, with 2 W of power, a pulse length of 0.5 ms continuous wave. So, the damage may be explained due to the excessive power used.

Because every clinical situation is different depending on the practitioner individual performance, it should be left to the practitioner to use his own judgment to increase or decrease the power of laser.

The differences between reported investigations may be related to the differences in the laser parameters as well as other factors affecting soft tissue metabolism. In addition, the threshold parameters of energy density and intensity are biologically independent of one another. This independence accounts for both success and failure of laser therapy achieved at low energy density levels.

Dentist must not only provide the best dental and facial results possible but also deliver esthetics soft tissue results efficiently. Based on the results of this study, both diode laser and scalpel can be used for dental surgery patients.

The limitation of this study include small sample size investigated and short flow up period.

6. CONCLUSION

All tested clinical variables (pain, bleeding, swelling, wound healing) had no statistically significant difference between the laser and scalpel groups. Therefore treatment protocol including careful training in oral hygiene, combined with a valid surgical technique is therefore essential to obtain the best result of soft tissue healing.

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