Comparing the outcomes of incisions made by colorado microdissection needle, electrosurgery tip, and surgical blade during periodontal surgery: A randomized controlled trial

Rampalli Viswa Chandra, Boya Savitharani, Aileni Amarender Reddy

Abstract:
Context: Electrosurgery offers many unique advantages such as hemostasis and precise tissue cutting; however, there are a number of disadvantages including thermal injury and delayed wound healing. Aims: The aim of the present study was to compare the outcomes of incisions made by Colorado® microdissection needle, electrosurgery tip, and surgical blade during periodontal surgery. Settings and Design: Twenty-two individuals participated in this study. Three quadrants in each individual were randomly assigned into each of the following experimental groups: Colorado® microdissection needle (CMD), electrosurgery tip (EC) and surgical blade (BP), in which, incisions were given with Colorado® microdissection needle, straight electrocautery tip, and a scalpel blade, respectively. Materials and Methods: Blood loss (BL) was measured immediately after surgery, and changes in interdental papilla dimensions were recorded at baseline, 7, 30, 120, and 180 days after surgery. Measures of periodontal disease were recorded at baseline, 120, and 180 days after surgery. Results: The use of CMD for periodontal surgery showed better results over EC in all parameters. CMD resulted in lesser bleeding and less postoperative pain and attained similar results to that of BP in clinical parameters of periodontal disease. Conclusions: Colorado® microdissection needle may be a better choice for incisions as it seems to show less tissue damage than cautery and offers tissue healing comparable to scalpel blade.

Key words: Electrosurgery, microdissection, periodontitis, surgical incision

INTRODUCTION

Periodontal surgical procedures start with an incision[1-7] which can be given with a panoply of instruments such as a scalpel, electrosurgical tips, or lasers.[8] For most of the incisions, scalpel is preferred due to its ease of use, inexpensive nature, accuracy, and minimal damage to adjacent tissues. Scalpel incisions can be delivered with precision and result in favorable wound-healing characteristics; however, they are associated with drawbacks such as excessive blood flow in the operative field leading to inadequate visibility.[4-6] Injuries to dental personnel occurring during placement, transfer, use, and disposal of the blade is also a realistic possibility.[4-6]

The term electrosurgery refers to the passage of high-frequency alternating current through the tissue to achieve a predetermined surgical effect.[7] Electrosurgery offers many unique advantages over scalpel such as hemostasis, precise tissue cutting with minimal pressure, and sterilization of the surgical field.[4]

While this hemostatic capability represents a major advance, there are a number of disadvantages associated with electrosurgery including thermal injury and delayed wound healing.[9] Consequently, emerging electrosurgical technologies such as insulated cutting electrodes, ultrasonic blades, and feedback-controlled radiofrequency generators have been introduced and developed primarily to reduce thermal damage while preserving the hemostatic ability.[6,9]
Studies have shown that heat generated by electrosurgical devices is influenced by factors such as duration of contact between tissue and electrode, current intensity, electrosurgery waveform, and the electrode tip size. A larger tip causes more tissue damage, increased operating power, and more amount of lateral heat production. This led to the concept of microdissection needle with fine electrode tips and efficient power usage. Evidence from nondental studies seems to suggest that the use of microdissection needles does not have any significant difference in wound healing or pain over scalpel blades.

One such microdissection needle system is the Colorado® microdissection needle (Stryker-Leibinger, Freiburg-im-Breisgau, Germany) which combines the advantages of scalpel and electrosurgery resulting in a wide array of applications in the field of ophthalmology, neurosurgery, and others. The primary feature of the Colorado® microdissection needle is an ultrasharp tungsten tip that concentrates the waveform from the electrosurgery generator to a very small spot. This allows for the use of extremely low wattages, resulting in less tissue necrosis, precision cutting, cauterization, and less postoperative pain. The instrument tip is a delicately machined, insulated tungsten diathermy needle that is compatible with any standard cautery handpiece and system. Tungsten, with its extremely high melting point (>3400°C), provides a heat resistant tip that maintains sharpness compared to stainless steel tips that dull rapidly.

Till date, there is a paucity in studies on the use of Colorado® microdissection needle in periodontal surgery. This study compared the effectiveness of Colorado® microdissection needle with scalpel and electrosurgery by assessing measures of blood loss (BL), interdental papilla dimensions, periodontal disease, postoperative pain, and wound healing.

**MATERIALS AND METHODS**

**Study design**

The study was designed as a split-mouth, double-blind, randomized controlled clinical trial. Approval from the institutional review board was obtained (SVS/PER/2014/003), and this study is registered in ClinicalTrials.gov under the title “Comparing the Outcomes of Incisions Made by Colorado® Microdissection Needle” (NCT03003624).

**Sample size calculation**

The sample size was calculated by considering this trial as a noninferiority/superiority trial. A minimum sample size of 19 individuals is required to discern a difference of 1 mm of probing depth with α confidence level of 95% and β confidence level of 80%.

**Source of data [Figure 1]**

From an initial sample pool of 154 individuals who received supragingival plaque control, scaling and root planing (SRP) and supportive periodontal therapy 8 months before the beginning of the study, 22 fully dentate, systemically healthy individuals between 25 and 45 years with full-mouth average periodontal pocket depth probing pocket depth (PFD) ≥4 mm and with a minimum of 4 active residual pockets of ≥5 mm/quadrant suitable for modified Widman flap were included in the study. Patients who have used antibiotics, antioxidants, and/or anti-inflammatory agents within 8 months of baseline, smokers, pregnant and lactating women were excluded from the study.

**Randomization and blinding**

Randomization and blinding included computerized generation of the allocation sequence in random permuted blocks (block randomization). Allocation was performed by assigning the block of therapies to individuals according to the specified sequence [Figure 1]. Based on the sequence, three quadrants in every individual were randomly assigned into each of the following experimental groups: CMD, EC, and BP, in which incisions were given with Colorado® microdissection needle (Stryker-Leibinger, Freiburg-im-Breisgau, Germany), straight electrocautery tip (Art® electrocautery, Bonart Co, New Taipei, Taiwan), and a scalpel blade (Surgical Scalpel Blade No. 15, Swann-Morton, Sheffield, UK), respectively. All the surgeries were performed by a single designated operator BS for the sake of uniformity whereas the relevant readings were recorded by the first operator who was blinded to the nature of the group RVC. The blind was not broken until this clinical trial was completely finished.

**Study protocol**

All baseline (on the day of surgery) values were recorded before the surgical procedure. Quantity of BL, changes in interdental papilla dimensions, periodontal disease, postoperative pain, and wound healing were excluded from the study.
Dimensions of interdental papillary height (PH), PPD, and clinical attachment loss (CAL) are the primary outcome variables. Other clinical parameters included noninvasive measures of the secondary variables, measures of plaque index (PI), modified gingival index (MGI), postoperative pain visual analog scale (VAS), and wound healing EHS were the secondary outcomes.

PPD and CAL were recorded at six sites per tooth for a quadrant under study by using a University of North Carolina no. 15 (API® Probe UNC15, Delhi Med, Delhi, India) color-coded periodontal probe at baseline, 120, and 180 days after surgery.

BL during surgery was estimated by using swab weighing technique, in which using sterile gauze pieces was divided into small lots and preweighed before surgery. The lots once used were then reweighed immediately after surgery before discarding them from the operative field. From their variance in weight (lot wise) between the two (b-a), BL was calculated using the formula: Volume (ml) = Weight (gm)/Density (gm/ml). Saliva is considered negligible since the patients served as his or her own control, and surgeries were performed at the same time of the day to avoid any change in the salivary flow due to circadian rhythm. VAS was assessed by using VAS on days 1, 7, and 15 after surgery. Early healing index (EHI) was recorded using the early wound healing index graded as (1) Complete flap closure – no fibrin line in interproximal area, (2) Complete flap closure – fine fibrin line in interproximal area, (3) Complete flap closure – fibrin clot in interproximal area, (4) Incomplete flap closure – partial necrosis of interproximal tissue, and (5) Incomplete flap closure – complete necrosis of interproximal tissue. PH was calculated as the distance from the top of the papilla to the base of a line connecting the midfacial soft tissue margin of
the two adjacent teeth. The mean buccal value/quadrant was calculated at baseline, 7, 30, 120, and 180 days after surgery.[14]

Surgical procedure
Entire sterile armamentarium (Perio Surgery Kit®, Power Dental U. S. A Inc., McHenry, USA) was set up in working order before the surgical procedure, and modified Widman flap procedure[4,13] on all individuals was performed by one clinician BS. Preprocedural rinse was given (Betadine® gargle, Win Medicare, New Delhi, India) for 1 min, and following local anesthesia, internal bevel, sulcular, and horizontal incisions were made either with a straight 3 cm long Colorado® microdissection needle (Type N103A), straight electrocautery tip (Type T4-Fine Wire Tip), or with a scalpel blade No. 15 [Figure 2] depending on the group a quadrant was allotted to. Straight electrocautery tip was used at a minimum power setting of 5 in cutting mode, and Colorado® microdissection needle was used at power setting of 3 in cutting and coagulation mode. After the incisions were made [Figure 3], flaps were elevated by means of a periosteal elevator. Care was taken to ensure that the active electrode was not in contact with tissue for more than 1–2 s at a time, and successive applications of the electrode on the same spot were done after a 10 to 15 s interval.[7,11-13,15] The soft tissue collar incorporating the pocket epithelium was removed, and thorough degranulation was done followed by systematic SRP of the root surfaces using fine curettes or ultrasonic instruments under direct vision. Minimal osteoplasty if required was performed as necessary. The flaps were then repositioned and 3–0 silk sutures (Mersilk® Black, 3-0, Ethicon, India) were given. Routine postoperative instructions and medications were prescribed for 5 days postoperatively.

Statistical analysis
Data were analyzed by GraphPad Prism® software version 6.0 (GraphPad Software Inc., La Jolla, USA) and SAS software® version 9.3 versions (SAS, New Delhi, India). Data were summarized by mean ± standard deviation for continuous data and median ± interquartile range for score data. The comparison between two groups of repeated measures data was done by two way analysis of the repeated analysis test. The comparison within a group of repeated measures data was done by one way analysis of the repeated analysis test followed by post hoc test. The comparison between two groups for continuous data/score data was done by unpaired t-test/ Mann–Whitney test. The comparison between three groups for the continuous data/score was done by one way analysis of variance test ANOVA/Krushkal–Wall’s test, and followed by post hoc test. P ≤ 0.05 was considered statistically significant and P ≤ 0.001 was considered as highly significant.

RESULTS
The mean age of the individuals (n = 22; 11 males) was 34.83 ± 12.72 years. Three individuals were lost to follow-up as a result of relocation (two) and persistent pain (one), and the final analysis was limited to 19 individuals (19 quadrants/group; 57 quadrants).

Intragroup comparisons
Papillary height
The mean papilla height (in mm) in CMD, BP, and EC groups was 4.267 ± 0.3219, 3.355 ± 0.3665, 3.452 ± 0.3702, 3.566 ± 0.3859, 3.693 ± 0.3973; 4.243 ± 0.3531, 3.186 ± 0.3299, 3.573 ± 0.3521, 3.678 ± 0.3567, 3.841 ± 0.3388; and 4.230 ± 0.3451, 3.215 ± 0.3334, 3.313 ± 0.3223, 3.434 ± 0.3262, 3.537 ± 0.3211 at baseline and end of 7, 30, 120, and 180 days, respectively. These changes in papilla height when compared from baseline to end of 7, 30, 120, and 180 days were highly significant (P ≤ 0.001) in all the treatment groups [Figure 4].

Probing pocket depth and clinical attachment loss
The mean PPD (in mm) in CMD, BP, and EC groups was 6.915 ± 0.4197, 4.189 ± 0.6212, 2.421 ± 0.3522; 6.917 ± 0.4823, 4.293 ± 0.5732, 2.507 ± 0.4387; and 6.953 ± 0.4831, 4.388 ± 0.5986, 2.565 ± 0.4484 at baseline, 120, and 180 days, respectively. The mean CAL (in mm) in CMD, BP, and EC groups was 5.556 ± 0.3942, 3.107 ± 0.6712, 1.415 ± 0.3334; 5.694 ± 0.4516, 3.206 ± 0.5542, 1.461 ± 0.3572; and 5.685 ± 0.3612, 3.325 ± 0.5659, 1.361 ± 0.3691 at baseline, 120, and 180 days, respectively. The reduction in PPD and CAL from baseline to 120 and 180 days was highly significant in all the three treatment groups (P ≤ 0.001) [Figure 4].

Plaque index and modified gingival index
The mean PI in CMD, BP, and EC groups was 1.645 ± 0.3628, 0.6591 ± 0.2733, 0.6136 ± 0.2145, 0.5862 ± 0.1756; 1.695 ± 0.3881, 0.8409 ± 0.3663, 0.6705 ± 0.3217, 0.6136 ± 0.2145; and 1.706 ± 0.3560, 0.8636 ± 0.4863, 0.6705 ± 0.3217, 0.6591 ± 0.2384 at the baseline, 7, 120, and 180 days, respectively. The mean GI in CMD, BP, and EC groups was 1.818 ± 0.5011, 1.227 ± 0.4289, 0.9091 ± 0.5264, 1.000 ± 0.6901; 1.773 ± 0.6119, 1.273 ± 0.4558, 1.091 ± 0.4264, 1.045 ± 0.7223; and 1.682 ± 0.6463, 1.273 ± 0.4558, 1.000 ± 0.4364, 0.9545 ± 0.6530 at the baseline, 7, 120, and 180 days, respectively. This decrease in PI and GI when compared from baseline to end of 7, 120, and 180 days was highly significant (P ≤ 0.001) in all the treatment groups.

Visual analog scale and EHI Scores
The mean VAS scores in CMD, BP, and EC groups were 5.091 ± 0.6838, 1.000 ± 0.8165, 0.2273 ± 0.4289; 6.318 ± 0.7162, 1.909 ± 0.8679, 0.1364 ± 0.3513; and 5.409 ± 0.7964, 1.227 ± 0.6853, 0.3182 ± 0.4767 at baseline, 7, and 15 days, respectively. The mean EHI scores in CMD, BP, and EC groups were 3.091 ± 0.2942, 2.455 ± 0.5096, 1.409 ± 0.5032; 3.045 ± 0.2132, 1.636 ± 0.4924, 1.045 ± 0.2132; and 3.136 ± 0.3513, 2.682 ± 0.4767, 1.818 ± 0.5011 at baseline, 7, and 15 days, respectively. This decrease in VAS and EHI scores when compared from baseline to 7 and 15 days was highly significant (P ≤ 0.001) in all the treatment groups.

Table 1: Intergroup comparison of blood loss (ml) using one-way analysis of variance and intergroup comparison of pair-wise difference in blood loss (ml) using Bonferroni’s multiple comparison test

| Groups | Means ± SD | P       |
|--------|------------|---------|
| CMD    | 44.73 ± 11.19 | <0.001*** |
| BP     | 73.27 ± 14.98 |        |
| EC     | 48.82 ± 11.02 |        |

| Groups | Mean differences | P       |
|--------|------------------|---------|
| CMD versus BP | 28.55 ± 7.555 | <0.001*** |
| CMD versus EC  | 4.091 ± 1.083 | 0.2722   |
| BP versus EC   | 24.45 ± 6.473 | <0.001*** |

***Highly significant: Nonsignificant. SD – Standard deviation
Intergroup comparisons
Blood loss during surgery
The differences in BL were highly significant (P ≤ 0.001) across all the three treatment groups [Table 1]. The mean differences in BL between CMD and BP were highly significant (P ≤ 0.001) with BP showing higher BL. The mean difference in BL between CMD and EC groups was not significant [Table 1].

Probing pocket depth, clinical attachment loss, and papillary height
No significant differences were observed among the three groups for PPD and CAL at different time intervals [Figure 4]. Changes in papilla height were significant only between BP and EC groups at 30 and 180 days with BP showing more increase in papilla height. No significant difference in papilla height was observed between BP and CMD at different time intervals [Figure 4].

Plaque index and modified gingival index
No significant differences were observed among the three groups for PI and MGI at different time intervals.

Visual analog scale and EHI scores
Day 1: The mean difference in VAS score between CMD and BP was −1.227 and between BP and EC was −0.3182. More pain was observed with BP when compared to CMD and EC, and the differences were highly significant (P ≤ 0.001). The mean difference in VAS score between CMD and EC was 0.9091 which was not significant [Figure 5]. Day 7: BP showed more postoperative pain when compared with CMD and EC group and the differences were highly significant (P ≤ 0.001) and significant (P ≤ 0.05), respectively. No difference was observed between CMD and EC groups [Figure 5]. At the end of 15 days, no significant differences were observed among three groups. No significant differences in wound healing were observed among the three groups on day 1. At the end of 7 days, more favorable wound healing was observed with BP when compared with CMD and EC groups, and the differences were highly significant (P ≤ 0.001). No differences was observed between CMD and EC groups. At 14 days, the mean EHI between CMD and BP was 0.3636 which was statistically significant [Figures 5 and 6]. The mean wound healing between CMD and EC groups was 0.4091 and between BP and EC groups was −0.7727 which were significant and highly significant, respectively [Figure 5].

DISCUSSION
This present study was designed to compare the effectiveness of CMD, EC, and BP by assessing measures of BL, interdental papilla dimensions, periodontal disease, postoperative pain, and wound healing.

The present study reported a mean BL of 44 ml, 73.27 ml, and 48.82 ml with CMD, BP, and EC, respectively. The values are comparable to the following studies: Moore et al.\(^{[25]}\) reported 54.9 ± 36.0–70.2 ± 53.0 ml BL with conventional periodontal flap surgery with scalp, whereas Braganza et al.\(^{[26]}\) reported 17.8 ± 9.6–31.9 ± 15.7 ml BL based on preoperative NSAIDs intake. McIvor and Wengraf\(^{[27]}\) reported 12–62 ml BL when periodontal flap procedures were limited to one or two teeth. Zigdon et al.\(^{[28]}\) reported that BL during periodontal flap surgery ranged from 6.0 to 145.1 ml with an overall mean loss of 59.47 ± 38.2 ml. Both CMD and EC resulted in lesser BL with CMD resulting in least amount of BL. One of the advantages with electrosurgery is the minimal amount of BL following its use. In the present study, BP showed higher volumes of BL; this finding was in agreement with the studies conducted by Kearns et al.\(^{[29]}\) and Shamin et al.\(^{[30]}\) who reported that BL in electrosurgical incisions is lesser when compared to scalpel. Sheikh et al.\(^{[31]}\) reported approximately four times more BL with a scalpel when compared to the Colorado microdissection needle for scalp incisions in neurosurgical procedures. No significant difference in BL between CMD and EC has been observed in the present study. However, the fine insulated tip of CMD can simultaneously perform cutting and coagulation without compromising the precision of tactile feedback when compared with electrosurgery.\(^{[32,33]}\)

A significant reduction in papilla height was seen from baseline to 1 week in all three treatment groups. All groups received modified Widman flap surgery which involves splitting of the papilla just below the contact point.\(^{[34]}\) Electrosurgical procedures also have a deeper penetration to about 300–500 cell layers and vaporize water in the underlying soft tissue creating a “shrinking” effect.\(^{[35]}\) During healing, the development of interdental soft tissue craters or clefts is frequently observed resulting in a loss of PH as well.\(^{[34,36]}\) However, significant changes in papilla height were found between BP and EC groups at 30 and 180 days with BP group showing more increase in papilla height. The lack of thermal stresses in the tissue and the ability to precisely split the papilla in the BP group may have resulted in better papillary healing over CMD and EC.\(^{[33–35]}\) CMD has a fine ultrasharp tungsten tip which can be used to place thinner and precise incisions as well in the interdental regions. At 180 days, CMD showed better papilla height gain over EC when compared to BP (0.14 mm vs. 0.28 mm). This different however was not significant.

The reduction in PPD and CAL from baseline to the end of study period was highly significant in all the three treatment groups. No significant intergroup differences at different time frames however were observed among all the groups. CMD and EC have been used as an adjunct to flap surgeries leading to reduction in PD and improvement in CAL.\(^{[3–5]}\) The use of cautery has the potential to cause delayed periodontal healing because of secondary wound contamination.\(^{[5–11,12–14]}\) This does not seem to be the case in this study as no significant differences were observed among the three groups for PPD and CAL at different time intervals.

Less postoperative pain was observed with CMD at 1st and 7th postoperative days. These results correlate with the previous studies\(^{[27,37]}\) which have shown that by reducing the surface area of cautery device, microdissection needles can maintain high power densities at relatively low wattages. The net result allows for lower dissipation of heat into surrounding tissues which results in lower thermal injury and postoperative pain.\(^{[15,37]}\) However, no significant differences have been observed among all groups at the end of 15 days.

Assessment of healing after 7 and 15 days revealed that healing of the quadrant treated by BP was best among all. Delayed
healing in case of EC can be attributed to damage produced by lateral heat.\[38\] Lateral heat damage is the area of coagulation necrosis produced around the incision line due to unwanted heat production; histologically, it is 0.12-0.31 mm wide.\[38,39\] When compared with EC, CMD showed improved healing at 7th and 15th postoperative days. Our clinical results are supported by previous studies,\[17,37\] in which the histological appearance of tissue that was subjected to the microdissection needle tip was compared with standard electrosurgery. These studies showed that decrease in thermal injury by the needle tip is attributable to the decreased power requirement and a more focused needle.\[17,37\]

The overall mean PI and MGI scores for all the individuals were assessed from baseline to 6 months to assess the overall oral hygiene status of the patient during the study period to avoid any confounders in the study. Although PI and MGI reduced significantly from base line to 6 months, no significant differences were observed among the three groups at different time intervals. This can be attributed to continuous standard and reinforced oral hygiene instructions given to the patients during every visit.\[190\]

This study has some limitations that need to be acknowledged. There is limited literature on the use and evaluation of CMD in periodontal surgery, and a direct comparison of the results in this study with similar studies was not possible. Literature was also scant on the ideal settings of CMD for intraoral use. The authors decided to use CMD at a power setting of 3 in cutting and coagulation mode from the results obtained by running a pilot study. However, the results seem to suggest that Colorado\textsuperscript{o} microdissection needle can be used as a better alternative for electrosurgery and scalpel in performing periodontal surgeries. Further studies, taking into consideration the power settings and different types of CMD tips, are required to produce a general consensus on the use of microdissection needles in periodontics.

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**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**

1. Novak MJ. Diagnosis of periodontal diseases: Reaction paper. Adv Dent Res 1991;5:37-40.
2. Magnusson I, Low SB, McArthur WP, Marks RG, Walker CB, Maruniak J, et al. Treatment of subjects with refractory periodontal disease. J Clin Periodontol 1994;21:628-37.
3. Heitz-Mayfield LJ, Trombelli L, Heitz F, Needleman I, Moles D. A systematic review of the effect of surgical debridement vs. non-surgical debridement for the treatment of chronic periodontitis. J Clin Periodontol 2002;29 Suppl 3:92-102.
4. Ramfjord SP, Nissle RR. The modified Widman flap. J Periodontol 1974;45:601-7.
5. Ramfjord SP. Present status of the modified Widman flap procedure. J Periodontol 1977;48:558-65.
6. Christensen GJ. Soft-tissue cutting with laser versus electrosurgery. J Am Dent Assoc 2008;139:981-4.
7. Massarweh NN, Cosgriff N, Slakey DP. Electrosurgery: History, principles, and current and future uses. J Am Coll Surg 2006;202:520-30.
8. Oringer MJ. Broader horizons and indications for use of electrosurgery in oral surgery. Dent Clin North Am 1982;26:729-44.
9. Arashiro DS, Rapley JW, Cobb CM, Killoy WJ. Histologic evaluation of porcine skin incisions produced by CO2 laser, electrosurgery, and scalpel. Int J Periodontics Restorative Dent 1996;16:479-91.
10. LohSA, Carlson GA, Chang EL, Huang E, Palanker D, Gurtner GC, et al. Comparative healing of surgical incisions created by the PEAK PlasmaBlade, conventional electrosurgery, and a scalpel. Plast Reconstr Surg 2009;124:1849-59.
11. Bassetly K, Nadig G, Kapoor S. Electrosurgery in aesthetic and restorative dentistry: A literature review and case reports. J Conserv Dent 2009;12:139-44.
12. Butler PE, Barry-Walsh C, Curren B, Grace PA, Leader M, Bouchier-Hayes D, et al. Improved wound healing with a modified electrosurgical electrode. Br J Plast Surg 1991;44:495-9.
13. Allan SN, Spitz L, van Noort R, Black MM. A comparative study of scalpel and electrosurgical incision on subsequent wound healing. J Pediatr Surg 1982;17:52-4.
14. Groot G, Chappell EW. Electrocautery used to create incisions does not increase wound infection rates. Am J Surg 1994;167:601-3.
15. Papay FA, Stein J, Luciano M, Zins JE. The microdissection cautery needle versus the cold scalp in bicoronal incisions. J Craniofac Surg 1998;9:347-7.
16. Rokhsar CK, Ciocon DH, Detweiler S, Fitzpatrick RE. The short pulse carbon dioxide laser versus the colorado needle tip with electrocautery for upper and lower eyelid blepharoplasty. Lasers Surg Med 2008;40:159-64.
17. Farnworth TK, Beals SP, Curren B, Grace PA, Leader M, Bouchier-Hayes D, et al. Improved wound healing with a modified electrosurgical electrode. Br J Plast Surg 1991;44:495-9.
18. Peterson JL. Application of electrocautery in scalp reduction. Experience with an ultrasharp tungsten needle electrode. J Dermatol Surg Oncol 1994;20:209-12.
19. Saghaei M. An overview of randomization and minimization programs for randomized clinical trials. J Med Signals Sens 2011;1:55-61.
20. Lobene RR, Weatherford T, Ross NM, Lamm RA, Menaker L. A modified gingival index for use in clinical trials. Clin Prev Dent 1986;8:6-6.
21. Prasad KC, Prasad SC. Assessment of operative blood loss and the factors affecting it in tonsillectomy and adenotonsillectomy. Indian J Otolaryngol Head Neck Surg 2003;56:325-7.
22. Seymour RA, Charlton JE, Phillips ME. An evaluation of dental pain using visual analogue scales and the mcgill pain questionnaire. J Oral Maxillofac Surg 1994;20:209-12.
23. Wachtel H, Schenk G, Böhm S, Weng D, Zuhr O, Hürzeler MB, et al. Microsurgical access flap and enamel matrix derivative for the treatment of periodontal intrabony defects: A controlled clinical study. J Clin Periodontol 2003;30:496-504.
24. Bhat V, Shetty S. Prevalence of different gingival biotypes in individuals with varying forms of maxillary central incisors: A survey. J Dent Implant 2013;3:116-21.
25. Moore PA, Doll B, Delie RA, Hersh EV, Korostoff J, Johnson S, et al. Hemostatic and anesthetic efficacy of 4% articaine HCl with 1:200,000 epinephrine and 4% articaine HCl with 1:100,000
epinephrine when administered intraorally for periodontal surgery. J Periodontol 2007;78:247-53.

26. Braganza A, Bissada N, Hatch C, Ficara A. The effect of non-steroidal anti-inflammatory drugs on bleeding during periodontal surgery. J Periodontol 2005;76:1154-60.

27. McIvor J, Wengraf A. Blood-loss in periodontal surgery. Dent Pract Dent Rec 1966;16:448-51.

28. Zigdon H, Levin L, Filatov M, Oettinger-Barak O, Machtei EE. Intraoperative bleeding during open flap debridement and regenerative periodontal surgery. J Periodontol 2012;83:55-60.

29. Kearns SR, Connolly EM, McNally S, McNamara DA, Deasy J. Randomized clinical trial of diathermy versus scalpel incision in elective midline laparotomy. Br J Surg 2001;88:41-4.

30. Shamim M. Diathermy vs. scalpel skin incisions in general surgery: Double-blind, randomized, clinical trial. World J Surg 2009;33:1594-9.

31. Sheikh B. Safety and efficacy of electrocautery scalpel utilization for skin opening in neurosurgery. Br J Neurosurg 2004;18:268-72.

32. Sharma N, Sachdeva SD. A comparative study of electrosurgery and scalpel surgery. Heal Talk 2012;5:36-8.

33. Al-Qahtani AS. Post-tonsillectomy hemorrhage. Monopolar microdissection needle versus cold dissection. Saudi Med J 2012;33:50-4.

34. Renvert S, Nilveus R, Egelberg J. Healing after treatment of periodontal intraosseous defects. V. Effect of root planing versus flap surgery. J Clin Periodontol 1985;12:619-29.

35. Taheri A, Mansoori P, Sandoval LF, Feldman SR, Pearce D, Williford PM, et al. Electrosurgery: Part I. Basics and principles. J Am Acad Dermatol 2014;70:591.e1-14.

36. Becker W, Becker BE, Ochsenbein C, Kerry G, Caffesse R, Morrison EC, et al. A longitudinal study comparing scaling, osseous surgery and modified Widman procedures. Results after one year. J Periodontol 1988;59:351-65.

37. Rideout B, Shaw GY. Tonsillectomy using the Colorado microdissection needle: A prospective series and comparative technique review. South Med J 2004;97:11-7.

38. Gnanasekhar JD, al-Duwairi YS. Electrosurgery in dentistry. Quintessence Int 1998;29:649-54.

39. Ravishankar PL, Mannem S. Electro surgery: A review on its application and biocompatibility on periodontium. Indian J Dent Adv 2011;3:492-8.

40. Noble WH, McClatchey KD, Douglass GD. A histologic comparison of effects of electrosurgical resection using different electrodes. J Prosthet Dent 1976;35:575-9.