Comparative clinical evaluation of internal mattress sutures vs continuous independent sling sutures on interdental papilla height and periodontal healing in esthetic zone: Randomized Clinical Study

Rashmi Suhag[1], Nishi Tanwar[1], Shikha Tewari[1], Rajinder Kumar Sharma[1], Satish Chander Narula[1], Isha Goel[1]

[1]Post Graduate Institute of Dental Sciences, Department of Periodontology, Rohtak, Haryana, India.

Abstract

Aim: To compare effect of vertical internal mattress suturing and continuous independent sling suturing techniques applied in open flap debridement for treatment of periodontitis, on height of interdental papilla and periodontal wound healing in the esthetic zone.

Materials and methods: 40 patients having chronic periodontitis were divided randomly into two groups. In test group (n=20) vertical internal mattress sutures and in control group continuous independent sling sutures (n=20) were placed. Clinical parameters at baseline, 3months and 6 months were assessed.

Results: Interdental papilla height was maintained with vertical internal mattress sutures whereas significant ($p \leq 0.05$) papillary recession was observed with continuous independent sling sutures at 6 months follow up. Results in terms of periodontal wound healing showed consistently statistically significant improvement which was comparable in both the groups at 3 months and 6 months most post-surgery.

Conclusion: Outcome of flap closure by vertical internal mattress suturing technique are better for maintaining papilla height than continuous independent sling suturing technique while wound healing in terms of improvement in clinical parameters were comparable for both the groups.

Keywords: Gingiva; periodontitis; surgical flaps; suture technique, wound healing.

Introduction

Emergence of esthetic has now become a major concern in the periodontal therapy in day to day practice. Along with the restoration of lost teeth, the management and reconstruction of the interdental papilla as well is the priority in esthetic dentistry (Blatz *et al*.,1999). Apart from acting as a biological barrier in protecting the periodontal structures, interdental papilla also plays a critical role in aesthetics. There are lots of risk factors which lead to the development of open gingival embrasures or black triangle, which include periodontal disease, triangular crowns, root angulations, interproximal contact position , length of embrasure area (Zetu and Wang, 2005). Open gingival embrasures formation are also the consequence of post periodontal surgery such as modified widman flap procedures and osseous surgeries (Becker *et al*., 1988, Jenkin *et al*., 1990). Formation of open gingival embrasures leads to difficulty for the therapist and patients in performing plaque control procedures, which result in persistent soft tissue inflammation (Kokich, 1996).

Correspondence to: Nishi Tanwar
E-mail: nsh_tanwar@yahoo.co.in

Proper management of supracrestal soft tissue flap along with interdental papilla during suturing appears to be of crucial importance in ultimate outcome of surgical periodontal pocket management (Trombelli and Farima, 2012). Three overlapping phases leads to completion of wound healing after periodontal flap surgery including inflammation, granulation tissue formation, formation of matrix and remodeling (Twikesjo, 1992). One of the prerequisite for optimum periodontal regeneration is wound stability and undisturbed maturation of a fibrin clot adhering to root surface (Polimeni *et al*., 2006, Burkhardt and Lang, 2015). Wound stability is achieved by close approximation of wound margins for primary intention healing by proper suturing (Polson and Proye, 1983). For patient comfort, hemostasis and prevention of further bone destruction, accurate surgical flap apposition is mandatory (Silverstein *et al*., 2009).

Anchoring structures are necessary for securing movable tissues. The most easiest and secure anchor are teeth followed by gingiva (Moore and Hill, 1996). Continuous independent sling suturing technique is used for more secure flap position in periodontal surgeries. It also provides greater distribution of forces on the flaps, minimizes the need for multiple knots, and allows independent placement of buccal and lingual flaps while permitting precise flap placement and independently secures one flap's multiple interproximal papilla from other flap. Vertical internal mattress sutures provide precise placement and control of the flap edges. When it is desirable to have the papilla position more upright in the embrasure space, internal mattress sutures are used. Literature suggests that vertical mattress sutures may be used in esthetically demanding area in the anterior region which require the complete papilla fill in the interdental area (Louis *et al*., 2004, Cohen, 1994).

Both continuous independent sling suture and vertical internal mattress suture techniques have distinct advantages. Review of the available literature does not reveal high level of evidence observing the effect of vertical internal mattress suture technique and Continuous independent sling suturing techniques on maintaining the height of interdental papilla and periodontal wound healing in chronic periodontitis patients.

Considering the above mentioned both suturing techniques to be best for primary closure as well as maintaining the supracrestal tissue at the desired location, the present study was intended to determine the influence of vertical internal mattress suture and continuous independent sling suture on height of interdental papilla and periodontal healing in the esthetic zone.

Materials and methods

Study design

This double blind, randomized clinical study was conducted in Department of Periodontics and Oral Implantology, Post Graduate Institute of Dental Sciences (PGIDS), Rohtak. The study was in accordance with the ethical standards outlined in the Declaration of Helsinki 1975 (DoH), as revised in 2013. The protocol was approved by the Institutional Review Board, Pandit Bhagwat Dayal Sharma University of Health Sciences, Rohtak and the ethical approval was obtained from the ethical committee of PGIDS, Rohtak (PGIDS/IEC/2017/12 dated 30/11/17). This clinical study was registered under ClinicalTrial.gov NCT03429764.

A minimum sample size of 18 patients in each group was calculated by using G power software (G power software 3.1.9.2) and assuming that this sample size would be sufficient to detect a one mm clinically significant difference in probing pocket depth reduction and gain of one mm in interdental papilla height with standard deviation of 1 (Effect size:1) with α error 0.05) and power = 0.80.

Study population

Total 167 patients were screened from regular OPD in the Department of Periodontics and the study was conducted in 44 chronic periodontitis participants meeting the inclusion and exclusion criteria. Study period was from December 2017 to February 2019. All patients were informed about the procedure in detail and written informed consent was taken.

Inclusion criteria were: 1) patients with age 18-65 years and otherwise systemically healthy; 2) Teeth in maxillary esthetic zone including premolars with minimum three adjacent interdental papilla in teeth having tight contacts at the periodontal surgical site having moderate to severe chronic periodontitis (Armitage, 2000); 3) Possessing ≥20 natural teeth; 4) Pocket depth ≥ 5 mm, after 6 weeks of completion of phase 1 periodontal therapy 5) Completed etiological periodontal therapy {oral hygiene instructions and scaling and root planing with full-mouth bleeding score FMBS < 20% and plaque index score<1 (sillness n loe)} (Loe, 1967). Patients were excluded from the study who had loss of contact point in adjacent teeth at the surgical site; medically compromised patients who were on long term use of drugs which could affect the treatment and final outcome of the periodontal surgery; patients under systemic antibiotics in past 6 month; pregnant women and lactating mothers; smokers (current and past) and tobacco chewers; patient undergone periodontal treatment 6 months prior to the study.

Randomization and allocation

The study was Randomized Clinical Trial, patients were randomly divided and allocated with the help of computer generated software (Saghaei, 2004) by one of the investigator (N.T) to control group and test group. After performing open flap debridement, sutures (4-0 black silk sutures, MCo Hospital Aids Pvt Ltd.,Hubli, India) were placed according to the allocated sequence. In test group (TG) vertical internal mattress suture were placed at the surgical site and in control group (CG) continuous independent sling sutures were placed at the surgical site and (Figure 1a and 1b). Surgical procedure was done by the single operator (R.S). The clinical parameters from baseline to each follow up were evaluated by other investigator (S.T.), who was masked to patient's group allocation.

Four teeth involving three interdental papillae/sites were analysed in both the groups. Statistical analyses were applied on 60 interdental papillae in each group and total 120 interdental papillae/sites in both groups in this study.

Periodontal parameters

Full mouth periodontal parameters including probing pocket depth (PPD), clinical attachment loss (CAL) and bleeding on probing (BOP) were recorded for the inclusion of patients of chronic periodontitis. Site specific (surgically involved teeth) measurements included Plaque Index (PI), Gingival Index (GI), BOP, PPD, CAL, gingival recession (bREC), papilla tip to contact point distance (PTCP) and width of keratinized gingiva (WKG). PI and GI were calculated at four sites of each tooth and their mean was taken. Mean of clinical parameters (PPD, CAL and BOP) were taken at four sites i.e mesiobuccal, distobuccal, mesiopalatal and distopalatal of each interdental papilla in surgically involved teeth. BOP was assessed as a dichotomous measure (bleeding present or absent) within 15 seconds of probing. Gingival recession (bREC) was calculated at mid-buccal aspect of the surgically involved teeth to observe the changes in recession on buccal aspect of teeth for esthetic purpose.

Papilla Recession/ interproximal gingival level change was measured by two ways: PTCP was calculated as distance from apical aspect of contact point to tip of papilla (Chang, 2007) and WKG from mucogingival junction to tip of the papilla.

All the periodontal parameters were measured with the help of manual periodontal Probe (PCPUNC-15, Hu-Freidy, Chicago, USA).

Intra -examiner reproducibility

All clinical periodontal examinations were carried out by a single, calibrated investigator to preclude any intra-examiner variability. Calibration of examiner was performed by duplicating PPD and CAL measurements, 48 hrs apart on 10 randomly selected individuals prior to initiation of this study. A calibration exercise was performed until ≥ 90% reproducibility in PPD and CAL measurement was achieved.

Primary and secondary outcome variables

Papilla recession in terms of distance PCTP and WKG over 6 months was considered as the primary outcome variable of the study. Secondary variables included improvement in PPD, CAL, PI, GI, and BOP.

Experimental protocol

A total of 120 papilla meeting the eligibility criteria received initial phase-1 therapy was in the form of supragingival scaling and root planing with ultrasonic scaler (Ultrasonic scaler, Confident sales India Pvt. Ltd., Bengaluru, India), hand scalers and curettes (U15/30scaler, and Gracey curettes No. 1/2 and 5/6, Hu-Freidy, Chicago, USA) and recalled after 6weeks (S.T, N.T). Residual pockets ≥4mm not resolved with non-surgical therapy and indicated for surgery were included in the study. Surgical site was anesthetized with lignocaine with adrenaline 1:100,000 (2% lignocaine with 1:100,000 adrenaline, Alpha Laboratories Ltd., India).

After achieving adequate anesthesia, crevicular incision was made and full thickness mucoperiosteal flap was reflected on both sides. Root planing and granulation tissue debridement was done with manual instrumentation and ultrasonic tips. Once the pockets were debrided, edges of incision were repositioned and sutured using continuous independent sling sutures in control group and vertical mattress sutures in test group. Both the groups received 4-0 black silk sutures.

In test group vertical internal mattress suturing technique was used (Figures 1 to 4). In this technique the suture enters the buccal tissue just apical to the base of the papilla, passed through interdental area over the top of alveolar crest, and penetrates the palatal tissue from the inside-out apical to base of palatal papilla. Then through the palatal papilla suture passes back from the outside-in, 2 to 3 mm coronal to the previous point of suture penetration, and courses back across the alveolar crest exiting through the buccal papilla from the inside-out at a point 2 to 3 mm coronal to the initial buccal entry point. The buccal and palatal papillae were positioned together and the suture was tied bucally (Louis *et al*., 2004).

Figure 1. Vertical internal mattress sutures. A) baseline, B) vertical internal mattress sutures, C) 3 months follow up and D) 6 months follow up

Figure 2. Continuous independent sling sutures A) baseline, B) continuous independent sling sutures, C) 3 months follow up, D) 6 months follow up

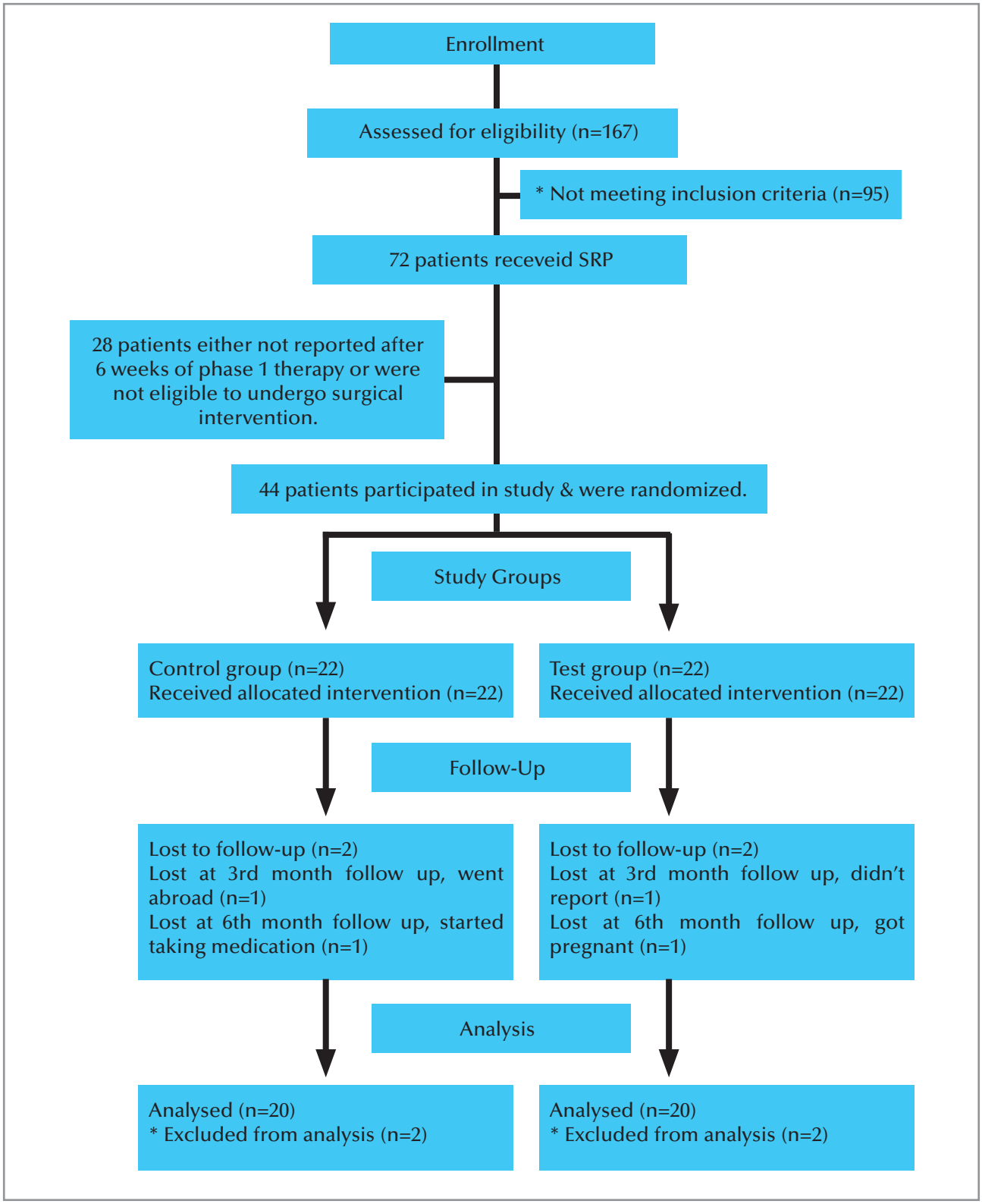

Figure 3. Flowchart of the study population.

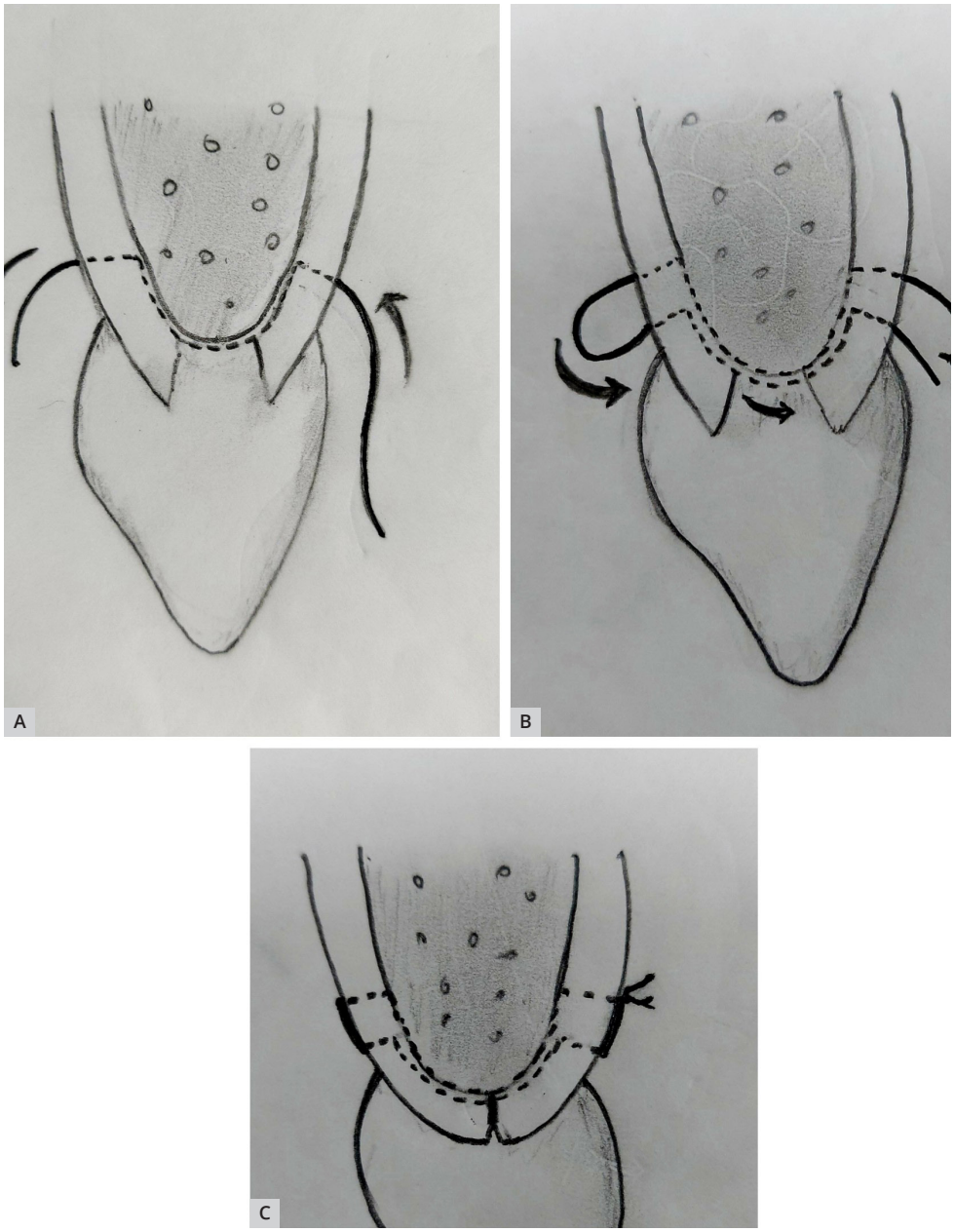

Figure 4. Vertical internal mattress sutures: A)The suture enters the buccal tissue just apical to the base of the papilla from the outside-in, passes through interdental area over the alveolar crest and penetrates the palatal tissue from the inside-out, B)From the palatal tissue suture passes back 2 to 3 mm coronal to the previous point of suture penetration from the outside-in, passes through interdental area over the alveolar crest and exit through the buccal tissue from the inside-out, C)The buccal and palatal papillae positioned together and the suture was tied bucally

In the control group continuous independent sling suturing technique was used, suture is passed through the most anterior facial papilla from outside–in just coronal to the mucogingival junction and was looped around the lingual surface of tooth engaging the next facial papilla (Figures 2 to 5). The suture was not entering the lingual flap at this time. At each successive tooth, suture was encircled, penetrating the facial papilla slightly coronal to the mucogingival junction. At distal end of flap, the suture was passed through facial tissue and encircled back around the lingual of last tooth and through the interdental area mesial to the last tooth. The suture is then brought around the facial surface of the last tooth towards the distal aspect of lingual flap. Encircling the suture around the terminal tooth in this manner allows facial flap to be locked in placed and positioned independently of the lingual or palatal flap. The suture was then looped back around the facial surface of terminal tooth. The suture was passed through the interdental area to engage next papilla on the lingual or palatal flap. The lingual flap was sutured in a similar manner as the facial flap. The suture was tied anteriorly where the suture was initially introduced into the facial tissue (Louis *et al*., 2004).

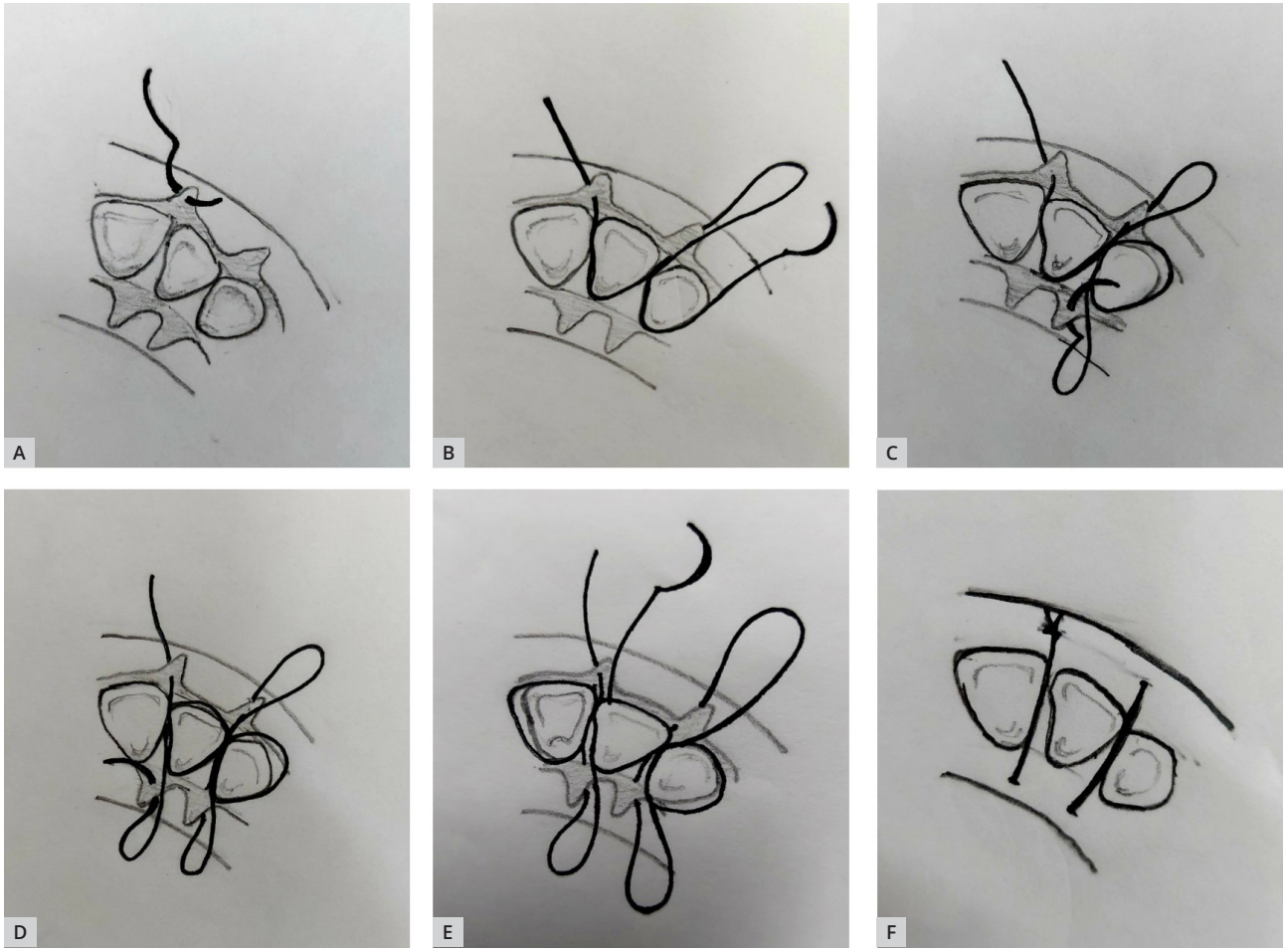

Figure 5. Continuous independent sling sutures: A) The suture was passed through the most anterior buccal papilla from outside–in just coronal to the mucogingival junction, B) Suture was looped around the palatal surface of tooth engaging the next buccal papilla and the step was repeated at each successive tooth, C) When the posterior most tooth was reached, the suture was anchored around it and then the suture was passed through the palatal flap from outside-in, D) The palatal flap was sutured in a similar manner as the buccal flap, E) The suture was again anchored around the anterior most tooth before the final knot is tied, f) The suture was tied anteriorly where the suture was initially introduced into the buccal tissue

Postoperative care: Mechanical oral hygiene measures were restricted in the operated area until the sutures were removed. Patients were advised rinsing with 0.2% w/v chlorhexidine gluconate (Dr Reddy's Laboratories Ltd) two times a day until they resume mechanical plaque control. All patients were prescribed ibuprofen 400 mg (Abott, India) thrice daily for three days. Sutures were removed after one week and patients were put on meticulous oral hygiene measures. Postoperative follow up was done weekly after surgery for one month then at 3months and 6 months encouraging the oral hygiene maintenance at every visit.

Statistical Analysis

Data recorded was processed by standard statistical analysis. All statistical analysis were carried out using statistical software (SPSS,Version 25.0 for Windows,SPSS,Chicago,IL). The normality of distribution of the data was assessed using the Shapiro-Wilk test and found non-normal distribution. Therefore, non-parametric test were applied for statistical analysis, wilcoxon-signed ranks test was applied for intragroup comparison and Mann Whitney U test for intergroup comparison. Statistical significance level was set at P=0.05. For statistical analysis, interdental papilla was taken as one unit and clinical parameters were taken at four sites i.e mesiobuccal, distobuccal, mesiopalatal and distopalatal.

Results

Patient flow through the study is presented in the CONSORT - Consolidated standards of reporting trials flow diagram shown in (Figure 3). A total of forty patients (20 in control group and 20 in test group) completed the treatment protocol. Total dropped out patients from the study were four in number. Wound

healing in both groups was uneventful. No bruising, wound dehiscence or pus discharge was observed in any group. Demographic characteristic and comparison of baseline periodontal parameters are shown in Table 1. The two groups were homogeneous, with no significant differences in age and gender. Furthermore, baseline assessment of clinical parameters revealed no statistical significant difference in between test and control group.

Intragroup comparison (Table 2 and 3) reveals statistically significant improvement in PI, GI, BOP, PPD and CAL in both the groups. Significant increase in distance PTCP and decrease in WKG was observed in control group at 6 months and non-significant difference in these parameters was observed in test group at 6 months interval. A significant papillary recession was observed in control group at 3 months and 6 months as compared to baseline.

Table 4 depicts intergroup comparison of periodontal parameters at baseline, 3months and 6months. Statistically significant difference was observed in distances PTCP and WKG at 3 months and 6 months interval in both groups.

Table 5 depicts intergroup comparison of distances PTCP and WKG at baseline and 1 month, a significant difference was observed in the both the parameters. Intergroup comparison of PTCP and WKG at one month and 3 months was found to be statistically non-significant.

Table 1. Demographic characteristics of the study population and comparison of baseline parameters of control group and test group applying mann-whitney u analysis.

Parameters n=40	**Control group(CG) Continuous suture(n=20)**	**Test group(TG) Vertical internal mattress suture(n=20)**	**P-value**
Age(yrs) [x±Sd;range] 36.25 ± 9.44 (29-56)	37.19 ± 9.5 (29-56)	37.25 ± 6.9 (29-55)	0.79
Gender[n(%)] **Female** **Male** 13(32.5%) 27(67.5%)	6(30%) 14(70%)	7(35%) 13(65%)	0.74
Sites[n(%)]			
Anterior **Posterior** 96(75.5) 46(25.5)	46(67.3) 34(33.7)	50(72.2) 30(28.3)	0.39
PI	0.45 + 0.29	0.45 + 0.35	0.99
GI	0.51 + 0.37	0.46 + 0.35	0.55
BOP(%)	39 + 28	42.1 + 32.7	0.77
PPD	4.89 + 1.04	4.72 + 0.88	0.40
bREC	0.16 + 0.43	0.11 + 0.37	0.22
CAL	4.09 + 1.41	3.72 + 1.49	0.18
PTCP	1.09 + 1.09	0.93 + 0.99	0.39
WKG	7.61 + 1.53	7.72 + 2.07	0.93

P value >0.05 indicates non-significance.

Table 2. Intragroup comparison of parameters in control group by applying Wilcoxon signed rank test.

Parameters	Baseline	3 Months	P value
PI	0.45 + 0.29	0.18 + 0.27	0.00*
GI	0.51 + 0.37	0.16 + 0.27	0.00*
BOP(%)	39 + 28	8.3 + 17.39	0.00*
PPD	4.89 + 1.04	3.18 + 0.90	0.00*
bREC	0.16 + 0.43	0.45 + 0.54	0.00*
CAL	4.09 + 1.41	2.67 + 1.12	0.00*
PTCP	1.09 + 1.09	1.53 + 1.09	0.00*
WKG	7.61 + 1.53	7.18 + 1.48	0.00*
Parameters	**Baseline**	**6 Months**	**P value**
PI	0.45 + 0.29	0.11 + 0.22	0.00*
GI	0.51 + 0.37	0.10 + 0.24	0.00*
BOP(%)	39 + 28	6.64 + 20.31	0.00*
PPD	4.89 + 1.04	2.40 + 0.58	0.00*
bREC	0.16 + 0.43	0.39 + 0.56	0.00*
CAL	4.09 + 1.41	2.20 + 0.87	0.00*
PTCP	1.09 + 1.09	1.53 + 1.09	0.00*
WKG	7.61 + 1.53	7.18 + 1.48	0.00*

P value < 0.05* indicates significance

Table 3. Intragroup comparison of parameters in test group by applying Wilcoxon signed rank test.

Parameters	Baseline	3 Months	P value
PI	0.45 + 0.35	0.16 + 0.22	0.00*
GI	0.46 + 0.35	0.13 + 0.23	0.00*
BOP(%)	42.17 + 32.79	14 + 25.19	0.00*
PPD	4.72 + 0.88	2.94 + 0.69	0.00*
bREC	0.11 + 0.37	0.12 + 0.40	0.32
CAL	3.72 + 1.49	2.42 + 1.18	0.00*
PTCP	0.93 + 0.99	0.96 + 1.02	0.08
WKG	7.72 + 2.07	7.69 + 2.08	0.08
Parameters	**Baseline**	**6 Months**	**P value**
PI	0.45 + 0.35	0.13 + 0.25	0.00*
GI	0.46 + 0.35	0.09 + 0.21	0.00*
BOP(%)	42.17 + 32.79	8.83 + 20.34	0.00*
PPD	4.72 + 0.88	2.37 + 0.58	0.00*
bREC	0.11 + 0.37	0.12 + 0.40	0.32
CAL	3.72 + 1.49	2.02 + 1.15	0.00*
PTCP	0.93 + 0.99	0.95 + 0.99	0.16
WKG	7.72 + 2.07	7.7 + 2.08	0.16

P value < 0.05* indicates significance

Table 4. Intergroup comparison of improvements (Δ) in parameters.

Change in Parameters at 3 months from baseline	Control gp	Test gp	P value
PI	0.27 + 0.36	0.29 + 0.36	0.93
GI	0.35 + 0.37	0.34 + 0.34	0.67
BOP(%)	30.67 + 29.10	28.17 + 36.48	0.56
PPD	1.72 + 0.53	1.79 + 0.50	0.33
bREC	-0.29 + 0.29	-0.01 + 0.06	0.00*
CAL	1.42 + 0.56	1.30 + 0.68	0.22
PTCP	-0.43 + 0.29	-0.02 + 0.11	0.00*
WKG	-0.43 + 0.32	-0.02 + 0.11	0.00*
Parameters baseline and 6 months	**Control gp**	**Test gp**	**P value**
PI	0.34 + 0.36	0.33 + 0.39	0.66
GI	0.41 + 0.47	0.37 + 0.39	0.42
BOP(%)	32.33 + 38.55	33.33 + 40.11	0.76
PPD	2.46 + 0.77	2.36 + 0.77	0.54
bREC	-0.24 + 0.31	-0.008 + 0.06	0.00*
CAL	1.88 + 0.91	1.71 + 0.83	0.35
PTCP	-0.43 + 0.29	-0.02 + 0.09	0.00*
WKG	-0.43 + 0.29	-0.02 + 0.09	0.00*

P value < 0.05* indicates significance

Table 5. Intergroup comparison of parameters at different time points.

Change in parameters n=40	Control group(CG) Continuous suture(n=20)	Test group(TG) Vertical internal mattress suture(n=20)	P value
PTCP (0-1 month)	-1.00+0.00	-0.51+0.11	0.00
PTCP (1-3 month)	0.57+0.29	0.66+1.0	0.23*
WKG (0-1 month)	-1.00+0.00	-0.51+0.11	0.00
WKG (1-3 month)	-0.57+0.32	-0.58+0.12	0.06*

P value >0.05* indicates non-significance.

Discussion

Management of chronic periodontitis patients involves establishment of a local environment and microflora compatible with periodontal health by mechanical removal of the subgingival biofilm (Newman, 2015). This can be achieved successfully by nonsurgical and surgical mechanical therapies provided adequate plaque control is maintained during the supportive phase of treatment (Heitz-Mayfield *et al*., 2002).

In presence of persistent moderate to deep pockets (>5 mm) even after a conscientious phase 1 therapy periodontal flap surgery is routinely applied procedure for removal of root surface noxious agents and inflamed tissue to have an ideal gingival and bone morphology without sacrificing investing and supporting tissues and compromising esthetics.

Wound healing following periodontal flap surgery at hard, non-shedding surfaces is a more complex process (Burkhardt and Lang, 2015). Moreover, primary closure of interdental area is technically more demanding. Hence management of supracrestal soft tissue flap along with interdental papilla during suturing appears to be of critical importance in ultimate outcome of surgical periodontal pocket management (Trombelli and Farima, 2012).

Flap stability and adaptation of margin of the gingiva are crucial factors for promoting optimal wound healing (Burkhardt and Lang, 2015). Stable flap, closely adapted to the root surfaces by sutures, better resist eventual tensile forces during the healing process and muscle pulls (Polson and Proye, 1983). In the current study, open flap debridement procedure was done

in the esthetic zone including premolars. A crevicular incision was given and the interdental papilla was preserved as much as possible, full thickness flap was elevated both buccally and palatally. Almost 6-7 mm of flap was reflected as the pocket depth was ≥ 5mm. To ensure good marginal flap stability and keeping in consideration the best anchor for suturing, the vertical internal mattress sutures and continuous independent sling sutures were given in the present study.

The result of the current study in terms of periodontal wound healing clearly demonstrate paramount role of suturing on flap adaptation. Periodontal wound healing in both the groups showed consistently significant improvement in all the periodontal clinical parameters (Table 2, Table 3) after 6 months of open flap debridement. Intergroup comparison also depicted comparable improvement in periodontal parameters in both the groups ($p<0.001$). In support of results of present study other investigators had also reported reduction in PD and gain in CAL (Lindhe *et al*., 1982, Pihlstrom *et al*., 1984, Isidor and Karring, 1986, Gaspirc and Skaleric, 2007). Plaque levels in the current study were found to be significantly improved in both groups at 3months and 6months follow up and these were greater than previous study (Nelson *et al*., 1997). Greater reduction in plaque score in the present study may be attributed to meticulous plaque control by patient which was a part of supportive periodontal therapy. A significant reduction in gingival inflammation was seen in the present study in both groups at 3 months and 6 months follow up ($p<0.001$). At 6months follow up both the groups showed very less bleeding sites which reflects achievement of periodontal stability in terms of periodontal health. Lang *et al.* concluded that absence of BOP is directly related to periodontal stability (Lang *et al*., 1990).

The result of the present study demonstrated recession in terms of reduction in interdental papilla height at 6 months follow up in control group, whereas in test group the papilla height was maintained at 6 months post-surgery which was achieved upto the baseline or presurgical level. This was due to more shrinkage of interdental papilla at one month follow up in control group than in the test group in spite of similar coronal tissue regrowth at 3 months.

At one month follow up, shrinkage of papilla height was more in control group than test group. The less shrinkage of papilla height in test group may be because of vertical mattress sutures, allowing good papillary stabilization and greater control of wound edges allowing eversion of wound edges which prevent depressed scar formation (Louis *et al*., 2004). These edges gradually flatten during healing to produce a leveled surface (Grabb and Smith, 1968). At 3 months follow up there was coronal regrowth of interdental papilla in both the groups This coronal shift of papilla was probably the result of improved tissue maturation as discussed by lindhe and Nyman (Lindhe and Nyman, 1980).

Conventional interrupted loop sutures are the most commonly applied sutures in open flap debridement (Nelson *et al*., 19770. Moreover it has been stated that when flap is raised from both buccal and palatal side, interrupted interdental sutures may cause one flap higher than the other, or may exert improper tension on one or both side (Dahlberg, 1969). It has also been documented that these sutures have the tendency to flatten interdental papilla, especially when the papillae are thin and undergoing the process of wound healing resulted in interproximal black triangle due to depressed scar formation (Newell and Brunsyold, 1985). Only one study demonstrated that incorporation of internal mattress suture in curtain technique which was used to preserve the esthetics in anterior teeth, is beneficial in maintaining integrity of interdental papilla. (Newell and Brunsyold, 1985). The present study also showed promising results in maintaining the height of interdental papillae incorporating vertical internal mattress sutures.

Periodontal surgeries like modified widman flap procedure and osseous surgery results in interproximal soft tissue craters (Becker *et al*., 1988, Jenkin *et al*., 1990). This leads to difficulties for both the therapist and patient in performing plaque control procedures, leading to persistent soft tissue inflammation and black triangle formation (Kokich, 1996).

Vertical internal mattress suturing technique provides closure for both deep and superficial tissue. These sutures reduce suture gap apico-coronally and produces broader and close adaptation of mucoperiosteal flap with underlying bone and root surface, thereby minimizing disturbance to healing. This produces thin blood clot and greater wound stability favoring healing by primary intention and reduced risk of post-operative infection (Burkhardt and Lang, 2015, Zuhr *et al*., 2017).

Continuous independent sling suturing technique is simple, have ability to anchor the flap by using teeth, permits precise flap placement which is a prerequisite for periodontal wound healing. They provides greater distribution of forces across the flap as both flaps are placed independently. These sutures also secure multiple interproximal papillae of one flap independently of the other flap (Silverstein *et al*., 2009, Louis *et al*., 2004, Cohen, 1994).

Taking into consideration the advantages of the vertical internal mattress sutures preserving the integrity of interdental papillae height and to provide high level of evidence the present study was conducted to evaluate the wound healing and effect on height of interdental papilla via both the suturing techniques The current

study observed that the outcomes of flap closure for periodontal healing were equal for vertical internal mattress suturing technique and continuous independent suturing technique. Interdental papilla height was better maintained by vertical internal mattress suturing technique than continuous independent sling suturing technique.

Infection rates following periodontal surgery when no antibiotics were used have been reported to be low, 1.8% (Powell *et al*., 2005) and no additional benefit of antibiotic was reported when compared to without antibiotic coverage in another study(Mohan *et al*., 2014). Post-operative use of antibiotics after flap surgery should be conservative to specific need so as to prevent emergence of antibiotic-resistant bacterial strains.

Strengths of the current study include establishing strict inclusion and exclusion criteria, thereby minimizing the confounders affecting the results of the study. For the same reason, patients included in both groups had comparable demographic variables at baseline. Limitations of the study include short follow up period, and lack of histological assessment postoperatively. The vertical mattress suturing technique can also be evaluated in different classes of interdental papillae and further studies are also suggested to observe the influence of periodontal phenotype in reconstruction of interdental papillae. Results of present study need to be ascertained by multicenter clinical studies conducted with longer follow up period.

Many factors affect interdental papillae integrity (Kois, 2001, Tarnow *et al*., 1992, Gargiulo *et al*., 1961). Surgical intervention must include minimal surgical intervention and appropriate suturing of the interdental papilla especially in the esthetic zone, as its reconstruction is difficult due to anatomic reasons and limited blood supply. This has to be kept in mind not only in interdental papillae but also in inter-implant papillae management.

Conclusion

In light of the above findings and within limitation of present study, it may be concluded that outcome of flap closure by vertical internal mattress suturing technique are better for maintaining papilla height than continuous independent sling suturing technique. This finding of the present study can be beneficial especially in esthetic zone as presence of intact interdental papilla plays critical role in esthetics.

References

Armitage GC. Development of a classification system for periodontal diseases and conditions. *Northwest Dent* 2000; **79**(6):31-35.

Becker W, Becker BE, Ochsenbein C, Kerry G, Caffesse R, Morrison EC, & Prichard J. A longitudinal study comparing scaling, osseous surgery and modified Widman procedures. Results after one year. *Journal of Periodontology* 1988; **59**: 351–365.

Becker W, Ochsenbein C, Tibbetts L, Becker BE. Alveolar bone anatomic profiles as measured from dry skulls. Clinical ramifications. *Journal of Clin Periodontology* 1992; **24**: 727–731.

Blatz MB, Hürzeler MB, Strub JR(1999) Reconstruction of the lost interproximal papilla--presentation of surgical and nonsurgical approaches. *Int J Periodontics Restorative Dent* 1999; **19**(4): 395-406.

Burkhardt R, Lang NP. Influence of suturing on wound healing. *Periodontol 2000* 2015; **68**(1): 270-281.

Chang LC. The association between embrasure morphology and central papilla recession. *J Clin Periodontol* 2007; **34**: 432-436.

Cohen ES. Sutures and suturing: Atlas of cosmetic reconstructive periodontal surgery 2nd ed. Philadelphia: Lea&Febiger 1994.

Dahlberg WH. Incisions and suturing: some basic considerations about each in periodontal flap surgery. *Dent Clin North Am* 1969; **13**: 149-159.

Gargiulo AW, Wentz FM, Orban B. Dimensions and relations of the dentogingival junction in humans. *Journal of Periodontology* 1961; **32**: 261–267.

Gaspirc B, Skaleric U. Clinical evaluation of periodontal surgical treatment with an Er:YAG laser: 5-year results. *J Periodontol* 2007; **78**(10): 1864-71.

Grabb WC, and Smith JW. Plastic Surgery: A Concise Guide To Clinical Practice Little, Brown and Co, Boston 1968.

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**: 92-162.

Isidor F, Karring T. Long-term effect of surgical and non-surgical periodontal treatment. A 5-year clinical study. *J Periodontal Res* 1986; **21**: 462-472.

Jenkins WM, Wragg PF, Gilmour WH. Formation of interdental soft tissue defects after surgical treatment of periodontitis. *J Periodontol* 1990; **61**(9): 564–570.

Kois JC. Predictable single tooth periimplant esthetics. Five diagnostic keys. Compendium Continuing *Education Dentistry* 2001; **22**: 199–208.

Kokich VG. Esthetics: the orthodontic-periodontic restorative connection. *Semin Othod* 1996; **2**:21-30.

Lang NP, Adler R, Joss A, Nyman S. Absence of bleeding on probing. An indicator of periodontal stability. *J Clin Periodontol* 1990; **17**(10):714-21.

Lindhe J, Nyman S. Alteration of the position of the marginal soft tissue following periodontal surgery. *J Clin Periodontol* 1980; **7**: 525-530.

Lindhe J, Westfelt E, Nyman S, Socransky SS, Heijl L, Bratthall G. Healing following surgical/non-surgical treatment of periodontal disease. A clinical study. *J Clin Periodontol* 1982; **9**: 115-128.

Loe H. The gingival index, the plaque index and the retention index system. *J Periodontol* 1967; **38**:610-616.

Louis F, Rose, Brian LM. Periodontics medicine, surgery, and implants Elsevier Mosby 2004; 398-399.

Mohan RR, Doraswamy DC, Hussain AM, Gundannavar G, Subbaiah SK, Jayaprakash D. Evaluation of the role of antibiotics in preventing postoperative complication after routine periodontal surgery: A comparative clinical study. *Journal of Indian Society of Periodontology*. 2014 Mar;**18**(2):205-12.

Moore RL, Hill M (1996) Suturing techniques for periodontal plastic surgery. *Periodontol 2000* **11**:103-111.

Nelson EH, Funakoshi E, O'Leary TJ. A comparison of the continuous and interrupted suturing techniques. *J Periodontol* 1977; **48**(5) : 273-81.

Newell DH, Brunsvold MA. A modification of the "curtain technique" incorporating an internal mattress suture. *J Periodontol* 1985; **56**(8) :484-487.

Newman MG, Takei H, Klokkevold PR, Carranza FA (2015) Carranza's Clinical Periodontology. Elsevier, California.

Pihlstrom BL, Oliphant TH, McHugh RB. Molar and nonmolar teeth compared over 6-1/2 years following two methods of periodontal therapy. *J Periodontol* 1984; **55**: 499-504.

Polimeni G, Xiropaidis VA, Wikesjö UME. Biology and principles of periodontal wound healing/regeneration. *Periodontol 2000* 2006 ; **41**:30-47.

Powell CA, Mealey BL, Deas DE, McDonnell HT, Moritz AJ. Post-surgical infections: prevalence associated with various periodontal surgical procedures. *Journal of Periodontology*. 2005 Mar; **76**(3):329-33.

Polson AM, Proye MP. Fibrin linkage: a precursor for new attachment. *J Periodontol* 1983; **54**(3) :141-147.

Saghaei M. Random allocation software for parallel group randomized trials. *BMC Med Res Methodol* 2004; **4**:26.

Silverstein LH, Kurtzman GM, Shatz PC. Suturing for optimal soft tissue management. *J Oral Implantol* 2009; **35**(2):82-90.

Tarnow DP, Magner AW, Fletcher P. The effect of distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. *Journal of Periodontology* 1992; **63**: 995–996.

Trombelli L, Farina R. Flap design for periodontal healing. *Endodontic topics* 2012; **25**: 4-15.

Twikesjö UM, Nilveus RE, Selvig KA. Significance of early healing events on periodontal repair: a rewiew *J Periodontol* 1992; **63**(3) :158-65.

Zetu L,Wang HL. Management of inter-dental/inter-implant papilla. *J Clin Periodontol* 2005; **32**: 831-839.

Zuhr O, Akakpo DL, Hürzeler M. Wound closure and wound healing. Suture techniques in contemporary periodontal and implant surgery: Interactions, requirements, and practical considerations. *Quintessence Int* 2017; **48**:647-660.