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Clinical and radiographic evaluation of the entire papilla preservation (EPP) technique versus modified minimally invasive surgical technique (M-MIST) in treatment of intraosseous defects in patients with stage III periodontitis: A randomized clinical trial

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Abstract---Aim: The aim of this randomized clinical trial (RCT) is to evaluate the clinical and radiographic effectiveness of Entire papilla preservation surgical technique (EPP) to Modified minimally invasive surgical technique (M-MIST) in the treatment of periodontal intraosseous defects in stage III periodontitis patients. Methodology: A total of twenty patients (20-60) years old suffering from Stage III periodontitis were recruited, assigned and allocated randomly to one of two groups, group A (intervention group) to receive Entire Papilla Preservation technique (EPP) and group B (control group) to receive Modified Minimally Invasive Surgical technique (M-MIST). Each patient presented intra-bony defects; the selected sites were divided

randomly into two treatment groups. Clinical attachment level gain (CAL gain) was recorded as primary outcome and recall appointments were carried out at 3-, 6- and 12-months post operatively. Radiographical parameters were evaluated pre-surgically and after 6 and 12 months. Patient satisfaction was evaluated at 12 months. A dropout of four patients were excluded during the study period. Results: Both groups demonstrated statistically significant improvement where group A exhibited 4.13 mm CAL gain at twelve months, while group B exhibited 3.81 mm CAL gain twelve months after treatment. Radiographic bone fill showed 2.58 .mm (57.95%) versus 2.37 mm (55.29%) at six and twelve months whereas patient satisfaction showed a score of 6.60 versus 6.42 respectively. Conclusion: This randomized controlled trial demonstrated that both EPP and M-MIST might represent a promising method for treatment of intraosseous defects, notably for CAL gain and bone defect fill in treatment of patients with stage III periodontitis.

Keywords---entire papilla preservation technique, periodontal surgery, minimally invasive surgery, intraosseous defects, periodontal regeneration.

Introduction

Periodontitis is defined as loss of periodontal attachment due to microbial associated host mediated inflammation. This would lead to the apical migration of the junctional epithelium allowing the bacterial biofilm to undergo apical widespread along the root surfaces of teeth causing bone resorption Tonetti et al, (2018).Intraosseous vertical defects are one of the consequences that could result from periodontitis and are classified according to their architecture based on the number of residual walls, defect width as well as topographic extension in relation to the tooth (Papapanou & Tonetti, 2000). It was reported in the literature that the clinical outcome of treating intraosseous defects using conventional periodontal surgeries was influenced by clot stability. The main objective of periodontal surgeries is directed at complete preservation of the interdental soft tissues to achieve primary closure over the intraosseous defected sites during the early phases of wound healing. Evidence shows that surgical techniques are highly predictable in the treatment of pockets associated with deep and shallow intraosseous defects affected majorly by the selected flap design. This led to the innovation of different minimally invasive flap techniques that aimed at reducing the surgical trauma, allowing blood clot stability, protecting the regenerating site, reducing patient discomfort postoperatively as well as minimizing surgical chair time Cortellini & Tonetti, (2012).

Cortellini et al. 2009 introduced the concept of space provision for regeneration with the modified minimal invasive surgical technique (M-MIST). The surgical approach consists of only buccal horizontal incision at base of papilla and connected with a tiny interdental access through small mesial and distal intra-sulcular incisions. Cortellini & Tonetti, (2009)a. Aslan et al (2017b) recently developed a flap design termed “Entire Papilla Preservation Technique” which

aimed to access the intraosseous defect using a tunneling approach through a vertical incision placed away from defect area, this technique has the advantage of completely preserving the integrity of the interdental papilla with accessibility to the defect for proper debridement.

A randomized clinical trial has compared the Entire Papilla Preservation Technique alone without using biomaterials to the same technique with the use of emdogain and bone substitute. It was found that though both groups had a significant gain in the clinical attachment level, the introduction of regenerative biomaterials caused no additive improvement over the surgical technique alone. The author concluded that the flap design was the determinant factor regarding the clinical outcome in the treatment of intraosseous defects Aslan et al (2020). This randomized clinical trial compared the clinical and radiographic efficacy of entire papilla preservation surgical technique (EPP) to Modified minimally invasive surgical technique (M-MIST) in the treatment of periodontal intraosseous defects in stage III periodontitis patients without the use of biomaterials.

Material and Methods

Study settings

The present randomized, controlled, parallel-grouped trial was carried out on patients aged 20- 60 years suffering from Stage III periodontitis with intraosseous defects. Subjects were randomly assigned into two equal groups; group A (intervention group) to receive Entire Papilla Preservation technique (EPP) and group B (control group) to receive Modified Minimally Invasive Surgical technique (M-MIST) Subjects were selected from the outpatient and postgraduate clinics of Oral Medicine and Periodontology department, Faculty of Dentistry, Cairo University and Oral Medicine and Periodontology department, Faculty of Dentistry, Badr University between the period of October 2019 to October 2020. Screening of patients was continued until the target sample was achieved. Identifying and recruiting potential subjects were achieved through patients' database. This clinical trial was registered in U.S. National Institutes of Health Clinical Trials Registry, ClinicalTrials.gov Identifier ID: NCT04100798.

Ethical Procedure

The study protocol was approved by the Ethics Committee of Scientific Research, Faculty of Dentistry, Cairo University (September/2019). The detailed operation and follow up periods were clearly described in details to all patients selected in this clinical trial.

Eligibility criteria

All subjects participated in this trial, signed a written consent and fully agreed to participate in this work. Inclusion Criteria were as follow: a) patients age between 20 and 60 years old, b) stage III periodontitis patient that had at least one tooth with two wall or combined two to three walled intraosseous defect ≥ 3 mm deep (assessed by trans-gingival probing, radiographic examination) with clinical attachment level (CAL) ≥ 5mm and pocket depth (PD) ≥ 6 mm, c) defect not

extending to a root furcation area, d) vital teeth, e) no history of intake of antibiotics or other medications affecting the periodontium in the previous 6 months, f) no periodontal therapy carried out in the past 6 months, g) able to sign an informed consent form., h) patients who were cooperative, motivated, and hygiene conscious with plaque index less than 20%, i) able to come for the follow up appointments needed.

Exclusion Criteria

- any systemic disease that contra-indicated periodontal surgery or might affect healing
- smokers
- pregnant females
- drug abusers
- previous periodontal surgery on the involved site

Power & sample size calculation

This power analysis used CAL gain after 1 year as the primary outcome. The effect size d = 1.507 was calculated based upon a minimal clinically significant difference in CAL gain = 2 mm and the standard deviation of the control group = 1.4 mm obtained from the results of Cortellini & Tonetti, (2011). Using alpha (α) level of (5%) and Beta (β) level of (20%) i.e., power = 80%; the minimum estimated sample size was a total of 16 subjects. The sample size was increased to a total of 20 subjects (10 subjects per group) to compensate for a dropout rate of 25%. Sample size calculation was performed using PS Power and Sample Size Calculations Version 3, January 2009. Pierpaolo Cortellini & Tonetti, (2011).

Grouping and randomization

A total of (20) patients were recruited, assigned and allocated randomly to one of two groups.: group A (intervention group) consisted of 10 patients who received Entire Papilla Preservation technique (EPP) and group B (control group) consisted of 10 patients who received Modified Minimally Invasive Surgical technique (M-MIST). For group A, one patient travelled to another country during the follow-up period and another patient had incomplete data during data analysis, accordingly both were excluded. For group B, two patients did not appear during the follow-up period and were thus excluded. The allocation was done using computer generated random numbers (Footnote) and was performed by the main supervisor (RO), the patients were allocated in a ratio of 1:1.

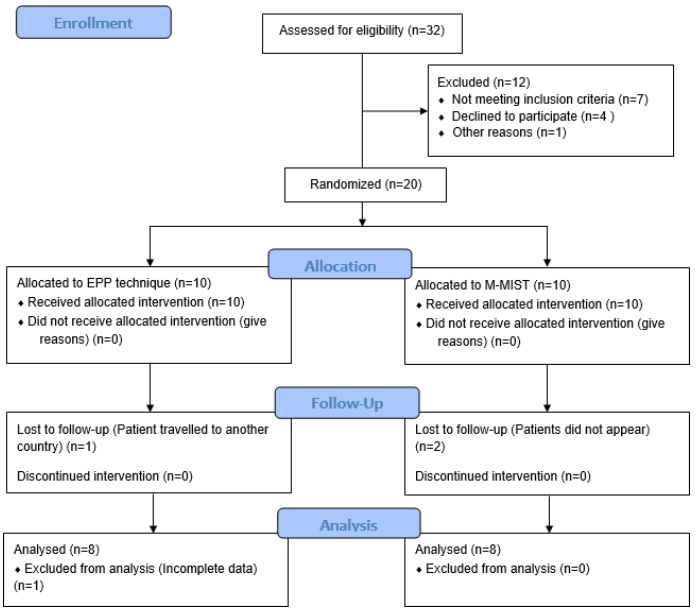

Figure 1, CONSORT flow diagram

Allocation concealment, Masking/blinding

The two set of patients were thoroughly made ready for both surgical procedures then the randomized numbers placed in the opaque sealed envelopes were picked by the main supervisor (RO) to determine which group would be nominated for the intervention group (Entire papilla preservation Technique (EPP)) and which would be nominated for the control group (Modified Minimally Invasive Surgical Technique (M-MIST)). The sealed envelope containing treatment assignment was opened at time of the surgery and the number was picked by another person other than the operator. Due to the type of intervention only the outcome assessor and the statistician were blinded. Single blinded: Blinding of the participants were not applicable. Blinding of the operator was not applicable.

Treatment Protocol

General operative procedures

Initial examination, including full mouth probing and radiographic examination to ensure the presence of interproximal bone loss was performed for the selected patients. Conventional pre-operative periapical radiograph was taken using size (2) periapical x-ray film and x-ray machine. The patients who fulfilled the inclusion criteria were enrolled.

Pre-surgical preparation

Patient motivation and education for proper oral hygiene instructions included twice-daily tooth brushing with soft toothbrush using modified bass brushing technique and once daily interdental cleaning with dental floss and interdental

brushes for wide interproximal embrasure spaces. All patients received strict oral hygiene instructions, full mouth supra and subgingival debridement using hand instruments and ultrasonic scalers under local anaesthesia. Universal and Gracey's curettes were used for proper subgingival debridement if needed. Patient preparation was completed in a single visit. Eight weeks following presurgical therapy, a periodontal re-evaluation was performed to confirm the suitability of the chosen sites for this periodontal surgical study, full mouth bleeding score had to be <20%.

Pre-operative preparation for digital radiographic procedures and fabrication of the radiographic stent

Construction of radiographic stent was done in order to perform an individualized Extension Cone Paralleling (XCP) index for each patient, a 5 mm stainless steel wire was embedded in the stent to allow precise calibration. Immediate preoperative radiograph was taken for each intraosseous defect using Digital x-ray machine with fixed exposure parameters; 70 Kvp, 4 mA and 0.5 second exposure time. Images were captured using standardized paralleling technique by the (XCP) alignment system with the radiographic stent and the large 3x4 cm phosphor storage plates (PSPs) imaging plate. The VISTA scanner scanned imaging plates automatically which served as a baseline radiograph for future comparisons.

Surgical Procedures

The patients were randomly assigned into two groups, group A (intervention) received entire papilla preservation technique (EPP). Operative area was anaesthetized by local never block or infiltration anaesthesia using articaine with epinephrine 1/100000. Buccal intra-sulcular incision was carried out at the interdental papilla related to the defect, and directed parallel to the long axis of the teeth involved. A single vertical incision was performed on the buccal gingiva of the adjacent interdental space of the same tooth away from the defect associated interdental papilla and was held forth just beyond the muco-gingival junction in order to provide good entry to the chosen interproximal defect. Reflection of a buccal full thickness flap was performed using a microsurgical muco-periosteal elevator extending laterally from the vertical incision to reach the intraosseous defect. Elevation of the defect associated interdental papilla was performed with the aid of tunnelling instrument that aimed for undermining incision that facilitated adequate accessibility to the intraosseous defect. Granulation tissue attached to the papilla was excised using a microsurgical scissor while those related to the bony defect were removed using a mini-five Gracey curette. Thorough root surface debridement was established using sonic/ ultrasonic Scalers. Primary soft tissue closure was performed by simple interrupted suture technique placed at the vertical released incision using 6-0 polypropylene suture.

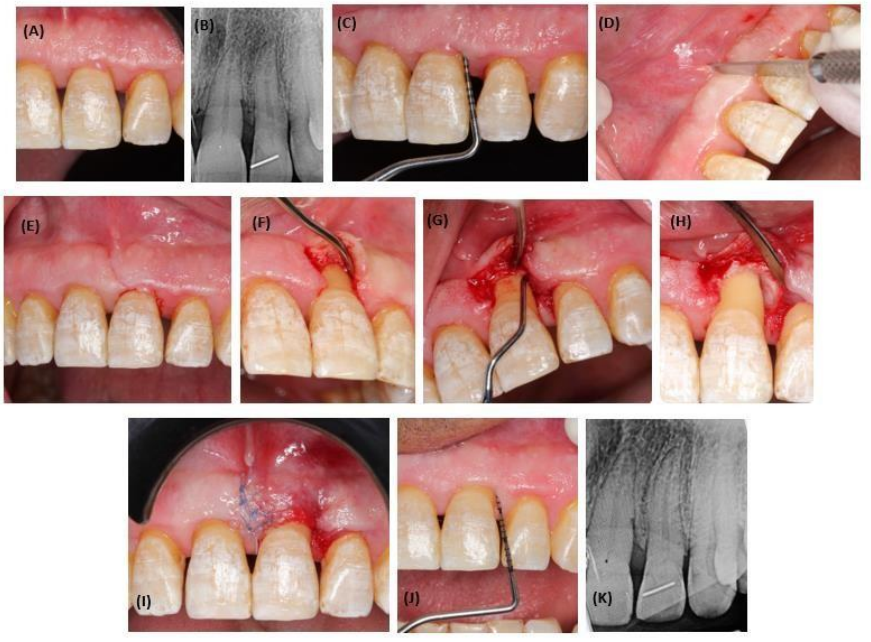

Figure 2: A representative case of the entire papilla preservation technique group. (A) Preoperative clinical condition. (B) Standardized radiograph that shows intraosseous defect related to the distal surface of the upper left central. (C) Clinical photo that shows seven-millimeter probing depth related to the distal surface of the upper left central using a UNC 15 periodontal probe. (D) Initial incision using a microblade no.67. (E) Flap design after incision. (F) Flap reflection using a micro periosteal elevator. (G) Using a mini five Gracey curette for debridement. (H) Defect morphology after debridement. (I) Suturing the flap using 6-0 polypropylene suture. (j) Clinical condition after 12 months follow-up that shows three-millimeter probing depth using a UNC 15 periodontal probe. (K) 12 months follow-up radiograph showing improved defect resolution.

Group B (Control) received modified minimally invasive surgical technique (M-MIST) Operative area was anaesthetized by local never block or infiltration anesthesia articaine with epinephrine 1/100000. Intra-sulcular incision was prepared to involve the buccal aspect of the two teeth adjacent to the defect. A horizontal or oblique interdental Papillary cut was performed based on the width of the interdental papilla. Reflection of a buccal full thickness flap using a microsurgical muco-periosteal was carried on. Partial dissection of the interdental papillary tissues was then performed with a number 67 microblade splitting the coronal part (basically the supra-crestal tissues) from the apical part which contained the granulation tissue filling the intraosseous defect. Granulation tissue related to the defect was removed using a mini five Gracey curette. Thorough root surface debridement was established using sonic/ultrasonic Scalers. The flap was then sutured to the defect related papilla using single modified internal mattress using suture 6-0 polypropylene suture.

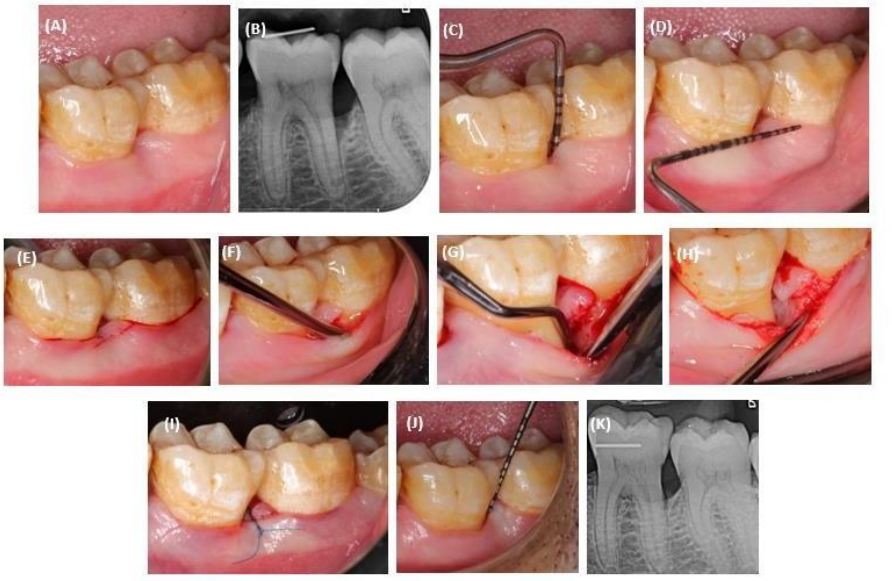

Figure 3: A representative case of the M-MIST group. (A) Preoperative clinical condition. (B) Standardized radiograph that shows intraosseous defect related to the distal surface of the lower left first molar. (C) Clinical photo that shows eight-millimeter probing depth related to the distal surface of the lower left first molar using a UNC 15 periodontal probe. (D) Measuring the width of the interdental papilla. (E) Flap design after incision using microblade no.67. (F) Flap reflection using a micro periosteal elevator. (G) Using a mini five Gracey curette for debridement. (H) Defect morphology after debridement. (I) Suturing the flap using modified internal mattress technique with 6-0 polypropylene suture. (j) Clinical condition after 12 months follow-up that shows three-millimeter probing depth using a UNC 15 periodontal probe. (K) 12 months follow-up radiograph showing improved defect resolution.

Postoperative Care

Postoperative medication consisted of amoxicillin (500 mg tabs) T.I.D for 7 days and Metronidazole (500 mg tabs) T.I.D for 7 days. Rinsing with Chlorhexidine 0.12% (B.I.D for 14 days). Patients were instructed to avoid brushing, flossing and chewing in the treated area for a period of 2 weeks. Sutures were removed after 1 week, three weeks post surgically the patients were instructed to gently brush the operated area with a soft toothbrush using roll technique. Patients were then recalled at 3, 6 and 12 months, scaling & oral hygiene instructions were done if needed.Radiographs were recorded followed at six and twelve months postoperative for detection of changes in the intraosseous linear measurements. The same radiographic procedures previously mentioned at immediate preoperative appointment were repeated at the follow up appointments. Finally, The radiographs were evaluated for the presence and the effictivness of the surgical procedure in the treatment of the intraosseous defect. Images of the treated teeth were manipulated using specially designed software of the Digora system. By this software the intraosseous defect measurements were performed.

Statistical methods

Numerical data was explored for normality by checking the data distribution, calculating the mean and median values and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data was represented as mean, standard deviation, standard

error and 95% Confidence Interval (CI) values. For parametric data; repeated measures ANOVA were used to compare between the groups as well as to study the changes by time within each group. For non-parametric data; Mann-Whitney U test was used to compare between the two groups. Friedman's test was used to study the changes by time within each group. Wilcoxon signed-rank test with Bonferroni's adjustment was used for pair-wise comparisons when Friedman's test was significant. Qualitative data was presented as frequencies and percentages. Chi-square test or Fisher's Exact test (when applicable) was used to compare between the groups. The effect size of the intervention was estimated by calculating risk ratios, Absolute Risk, Relative Risk and Number Needed to Treat with 95% CIs for binary outcomes and mean differences with 95% CIs for continuous outcomes. Inter-observer reliability (agreement) was measured using Cronbach's alpha reliability coefficient and Intra-Class Correlation Coefficient.

Results

The mean and standard deviation values were calculated for each group in each test. Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests, Recession, Gingival score and Satisfaction data showed non-parametric (not-normal) distribution (scores) while the rest of data showed parametric (normal) distribution. For non-parametric data: Mann Whitney test was used to compare between two groups in non-related samples Friedman test was used to compare between more than two groups in related samples. Wilcoxon test was used to compare between two groups in related samples. For parametric data: Independent sample t-test was used to compare between two groups in non-related samples. Repeated measure ANOVA was used to compare between more than two groups in related samples. Paired sample t-test was used to compare between two groups in related samples. Spearman correlation was used to find the correlation between different parameters. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

Clinical attachment level gain (CAL gain)

Table (1) and figure (4) present the assessment in CAL (mm) in Group A (EPP) and Group B (M-MIST) at each designated observation time elucidating that at baseline, 3rd, 6th, 12th months, there was no statistically significant differences in values between the two groups. Evidently, there was eminent statistically significant gain in CAL in each group assessed from baseline through all time intervals.

Table 1
The mean, SD values and results of comparison of CAL between the study groups at different time intervals

Variables	CAL							
	Group A		Group B		Mean Difference	95%CI of the Difference		p-value
	Mean	SD	Mean	SD		Lower	Upper	
Baseline	7.63	1.90	7.56	0.94	0.06	-1.55	1.67	0.935

								(NS)
After 3m	4.13	1.30	4.31	1.28	0.19	-1.20	1.57	0.776 (NS)
After 6m	3.63	1.30	3.81	1.03	0.19	-1.07	1.45	0.754 (NS)
After 12m	3.50	1.36	3.75	0.93	0.25	-1.00	1.50	0.674 (NS)
P1 (BL-3m)	< 0.001 (S)		< 0.001 (S)					
P2 (BL-6m)	< 0.001 (S)		< 0.001 (S)					
P3 (BL-12m)	< 0.001 (S)		< 0.001 (S)					

BL: baseline value; 3m: 3 months follow up; 6m: 6 months follow up; 12m: 12 months follow up; CI: confidence interval; S: significant difference ($p < 0.05$); NS: non-significant difference ($p>0.05$)

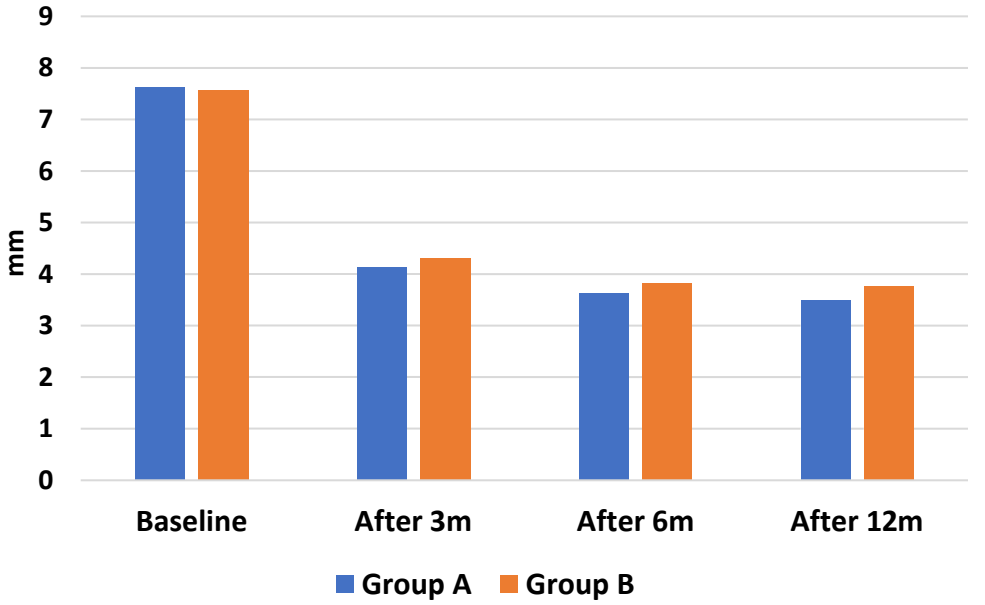

Figure 2. Mean values of CAL in the 2 groups at the different time intervals

Radiographic defect fill

Table (2) and figure (5) Present the assessment in defect depth (mm) in Group A (EPP) and Group B (M-MIST) at each designated observation time elucidating that at baseline, 6th, 12th months, there was no statistically significant differences in values between the two groups. Evidently, there was eminent statistically significant gain in defect depth in each group assessed from baseline through all time intervals.

Table 2
The mean, SD values and results of comparison of radiological defect depth between the study groups at different time intervals

Variables	Radiological defect depth							
	Group A		Group B		Mean Difference	95%CI of the Difference		p-value
	Mean	SD	Mean	SD		Lower	Upper	
Baseline	4.36	1.09	4.28	0.85	0.08	-0.97	1.13	0.874 (NS)
After 6m	2.82	0.60	2.94	0.70	0.12	-0.58	0.81	0.723 (NS)
After 12m	1.78	0.44	1.91	0.47	0.13	-0.36	0.62	0.567 (NS)
P2 (BL-6m)	< 0.001 (S)		< 0.001 (S)					
P3 (BL-12m)	< 0.001 (S)		< 0.001 (S)					

BL: baseline value; 6m: 6 months follow up; 12m: 12 months follow up; CI: confidence interval; S: significant difference ($p < 0.05$); NS: non-significant difference ($p > 0.05$)

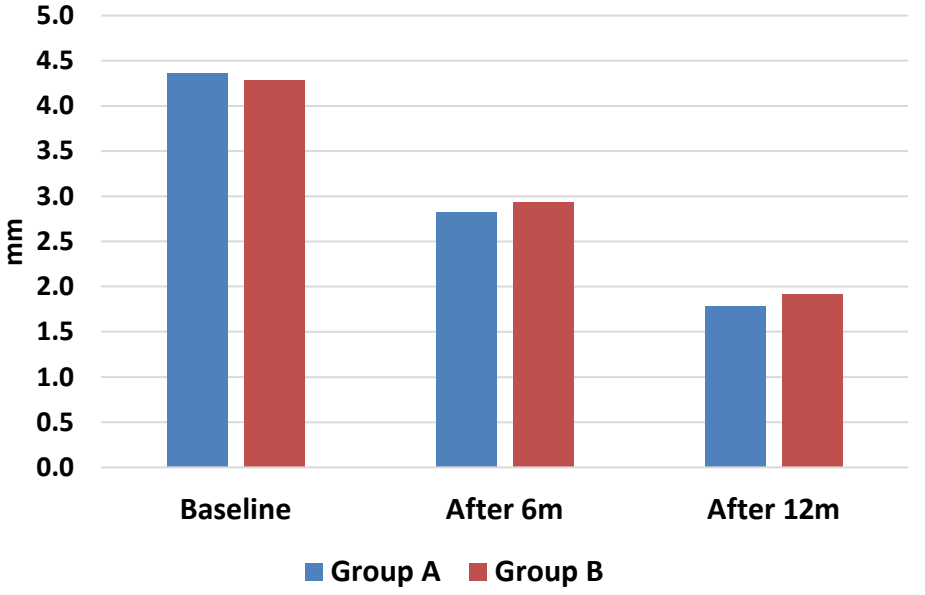

Figure 3. Mean values of radiological defect depth in the 2 groups at the different time intervals

Patient Satisfaction

Table (3) and Fig. (6) presents high patients satisfaction scores in both groups and without significant difference between them. where (p=0.595). The mean values for both group A and group B was 6.60 versus 6.42 respectively.

Table 3
The mean, standard deviation (SD) values of Satisfaction of different groups

Variables	Satisfaction			
	Mean	SD	Min	Max
Group A	6.60	0.44	6.00	7.00
Group B	6.42	0.49	5.67	7.00
p-value	0.595ns			

Means with different small letters in the same column indicates significant difference ns; non-significant (p>0.05)

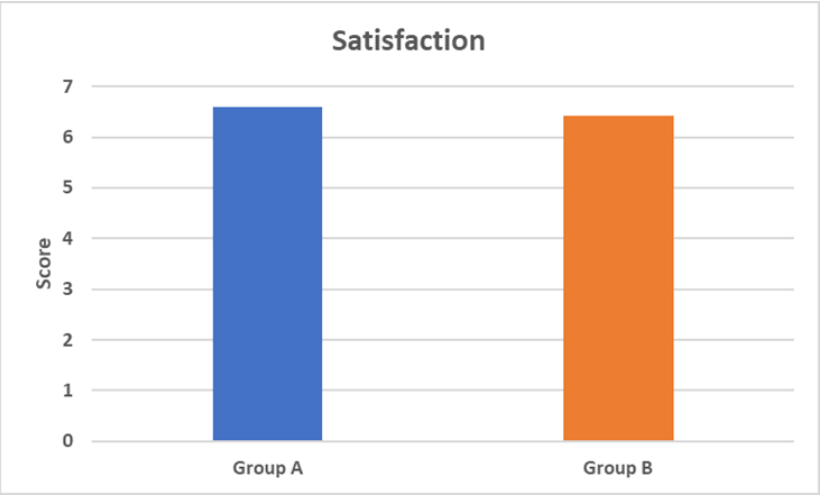

Figure 4. Bar chart representing comparison of patient satisfaction between

Discussion

Periodontitis is a microbially associated host mediated inflammation where progression causes loss of the supporting tissues around the teeth which involve the periodontal ligament, cementum and alveolar bone and eventually leads to tooth loss. Periodontitis can be diagnosed clinically when there is loss of attachment along with presence of bleeding on probing, and radio graphically when alveolar bone loss is evident Papapanou et al, (2018).

Stage III periodontitis is considered an advanced state of periodontal disease where risk of tooth loss becomes high and could occur. This stage is characterized by substantial damage to the periodontium where noticeable clinical attachment loss and deep periodontal pockets could be seen extending to the mid root. Also, vertical intraosseous defects and furcation involvement could be present which would further complicate the treatment. In these cases, the application of standard treatment principles involving the regular non-surgical treatment is insufficient to arrest disease progression and advanced periodontal therapy is required Tonetti et al, (2018).

Vertical intraosseous defects are osseous defects that occur due to alterations in the morphology of the alveolar bone as a result of bone resorption where the base of the defect is present apical to the surrounding bone and is associated with intrabony pocket. Intraosseous vertical defects have been associated with risk of periodontal progression in the absence of the appropriate therapy, the morphology of these osseous defects is influenced by the angle, depth and number of bony residual walls. Periodontal regeneration seen histologically as formation of bone and cementum was found to be positively correlated to the number of bone walls limiting the intraosseous periodontal defects with higher chances of successful outcome in favor of narrow deep intraosseous defects Kim et al., (2004); Vandana & Chandra, (2017); Nibali et al, (2020).

Over the previous century, the use of conventional periodontal flap designs for the treatment of intraosseous defects was associated with high risk of complications due to extensive flap reflection. These complications included loss of the interdental papilla, gingival recession, root sensitivity and crestal bone loss. In addition, the extensive surgical duration was associated with increased patient morbidity in the form of pain, edema, swelling and prolonged wound healing Sultan et al., (2020). The evidence available in the literature for the beneficial effects of minimal invasive approach in periodontal surgical procedures has been increasing in the recent years. Clinical results for this approach added benefits of reduced postoperative pain, improved rate of healing, maintenance of soft tissue height, and patient acceptance Harrel, (1999); Anderson & Pye, (2019).

Fundamental elements for performing “minimally invasive” surgery involve magnification, minimal flap extension and reflection, preservation of the papilla and interproximal supracrestal soft tissue, in addition to precise suturing technique. Various designs for a minimally invasive surgical approach have been introduced with smaller flaps designed to optimize wound stability, flap integrity, and healing by primary intention Ethan et al., (2021). M-MIST is a minimally invasive surgical procedure introduced by Cortellini & Tonetti, (2009)b that proved to have limited patient morbidity and excellent clinical outcome when used for the treatment of intraosseous defects. The technique emerged from modifying an earlier flap design known as “MIST” and aimed for preventing the interdental soft tissue from collapse, enhancing the stability of the blood clot in the area as well as minimize patient discomfort. On the contrary, a more recent technique was announced by Aslan et al., (2017)a that utilized a flap design to exceedingly preserve the integrity of the interdental tissue and to provide an intact gingival chamber over the intraosseous defect, with a completely preserved inter-dental papilla and garlanded their results with significantly high CAL gain and significantly high reduction in PD.

The aim of our study is to compare the clinical and radiographical outcome of the EPP technique versus M-MIST in the treatment of intraosseous defects in patients with stage III periodontitis as well as estimate patient satisfaction. The minimally invasive magnification loops and micro surgical instruments together with the inclusion of microsurgical suturing technique were determinant factors in our study that aimed to achieve the best wound stability which according to review published by Zuhr et al is an important key to successfully eliminate unnecessary trauma or excessive tensile strain during flap manipulation on the wound edges

and abort any negative impact on the healing quality. Our aim was to provide primary wound healing through protecting the blood clot from bacteria that could infiltrate the wound margin and thus restore rapidly the blood supply in the area allowing a provisional matrix to cover the wound. Failure of achieving this would result in secondary wound healing in the form of repair tissue that would lead to compromised treatment outcome Zuhr et al., (2017).

The establishment of a clinically healthy periodontal condition was found to be achieved when pocket closure occurred so that PD becomes less than or equal to 4mm with no bleeding on probing, this would lower the risk for disease progression as well as positively change the microbial environment in the subgingival area. Pockets that are equal to 5mm or more were reported to have high risk for periodontal breakdown Tomasi et al., (2007); Citterio et al., (2022). The present study showed that the two treatment modalities achieved significant improvement in clinical and radiographic parameters between baseline and after twelve months follow-up, however, comparing the two groups, there was no significant difference between the gain they both induced.

Intraosseous defects that were treated with EPP technique (group A) exhibited 4.13 mm gain in CAL twelve months after treatment. This is in accordance with a study by Aslan et al., (2020) who compared the use of EPP technique alone versus EPP technique with the addition of EMD and bovine derived bone substitute. In their study, the use of EPP technique alone led to a mean CAL gain of 5.83 mm. Compared to our results, this discrepancy could be related to the differences in the mean of clinical attachment loss and probing depth at baseline in both studies. Our study showed mean CAL of 7.63 mm at baseline while Aslan et al., (2020) showed mean CAL of 11.4 mm. Previous studies have shown a positive correlation between an increased baseline depth of the intraosseous component and the final improvement outcome thus, CAL gain is justified to be lower in our research Klein et al., (2001); Cortellini & Tonetti, (2015); Anderson & Pye, (2019); Shukla et al., (2019); Nibali et al (2020).

Our control group that was treated with M-MIST (group B) showed CAL gain of 3.81 mm twelve months after treatment. Our results agreed with Cortellini & Tonetti (2011) who compared the use of M-MIST alone versus M-MIST combined with EMD and M-MIST combined with both EMD and xenograft, they stated that the group that used M-MIST alone showed mean CAL gain of 4.1 mm which appear to be comparable to our clinical findings. The results of CAL gain in both groups of our study comes in accordance to a systematic review & a meta-analysis published by Clementini et al., (2019) that was conducted to assess the efficacy of minimally invasive periodontal surgeries and included eighteen studies, the study revealed a mean CAL gain of 3.89 mm. Noteworthy to mention that among the studies included were minimally invasive techniques that had biomaterials being used such as Emdogain, bone substitutes, membranes and growth factors. Their data elucidated that the use of biomaterials did not contribute to the improvement of their clinical parameters. On the contrary, it was stated that absence of regenerative materials in conventional surgeries had a drastic disadvantage on their outcome.

Considering the study of Aslan et al., (2020), They found that there was no significance difference between the EPP technique when used alone versus when used with EMD and bone substitute. The EPP control group was reported to have a mean CAL gain of 5.83 ± 1.12 mm while EPP with biomaterials provided a mean CAL gain of 6.3 ± 2.5 mm. As for Cortellini & Tonetti, (2011), they stated that the addition of biomaterials did not have an additional benefit to M-MIST for any of the evaluated parameters, pointing out that addition of EMD exhibited 4.1 ±1.2mm CAL gain, while combined EMD and xenograft showed 3.7 ±1.3mm CAL gain versus 4.1 ±1.4mm CAL gain for M-MIST alone. The findings obtained from omitting the use of biomaterials in all of these studies is interesting and raises a series of hypotheses that focus on the intrinsic healing potential of the surgical approach. Comparable results may lay on the fact that techniques that guarantee protection of the healing wound has the ability to enhance reconstruction of the intraosseous defect leaving little room for further improvement by the addition of biomaterials.

In the present study, alveolar bone changes in response to treatment were analyzed using a computerized image analysis program. In EPP and M-MIST group, there was a statistically significant gain in linear bone measurements after six and twelve months at the two selected areas measured from base of the defect to the alveolar crest. There was no significant difference between the two treatment groups. EPP group showed a radiographic bone gain of 2.58 mm while M-MIST showed 2.37 mm after twelve months. Their mean baseline defect depth was 4.17 and 4.13 mm respectively, this was interpreted as 57.95% and 55.29% bone gain. Clementini et al., (2019) reported comparable results exhibiting significant bone fill gain of 58.25% in intraosseous defects treated by minimally invasive techniques.

All patients participating in this study tolerated the surgical procedures well. No impediments were observed at any treated site. This observation came in accordance with the results of other studies that have shown that minimal invasive surgeries reduced the complication frequency to less than 10% and were associated with favorable patient compliance as well as more rapid healing Kiyak et al, (1984); Harrel, (1999); Cortellini & Tonetti (2007); Cortellini & Tonetti, (2009)b; Trombelli et al., (2009); Cortellini, (2012); Aslan et al., (2017)a. In our study, a post-surgical questionnaire was used after twelve months to evaluate patient satisfaction. Both groups were found to have high fulfillment with minimal discomfort. EPP group scored 6.6 out of 7 while M-MIST group scored 6.42 out of 7. These outcomes come in accordance with Tonetti et al, (2004) who stated that papilla preservation flaps were associated with uneventful healing, low risk for adverse effects as well as minimal postoperative pain and discomfort, and supported by Clementini et al., (2019) who asserted in his systematic review and meta-analysis, that minimally invasive surgeries recorded a very low VAS value of 1.16 for pain/discomfort.

Current evidence-based periodontology created a paradigm shift adding a new era in periodontal practice, where improved subject reported outcomes became the goal of clinicians and researchers. It has been proved that professionally evaluated outcomes were more stringent than subject evaluated outcomes. While periodontists struggle with less than perfect results, yet the professional “ideal”

may not always be as critical to the subjects. Although scientists may argue the relative statistical value of one surgical technique over the another, treatment success relates more to subject satisfaction than it does to "fractional" gain in clinical attachment or bone fill.

Conclusion

In conclusion, treatment of periodontal intraosseous defects using Entire Papilla Preservation technique (EPP) or Modified Minimally Invasive Surgical technique (M-MIST) produced significant improvement in clinical and radiographic parameters presented as significant gain in CAL and radiographic bone fill with no statistically significant difference when compared to each other. Both treatment modalities showed high patient satisfaction scores, in addition, clinical and radiographic outcome of minimally invasive techniques performed in this study without using biomaterials was found to be comparable to other studies when biomaterials were added.

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Conflict of interest

The authors have no proprietary, financial or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article

References

Anderson, W., & Pye, A. (2019). Management of intrabony defects in periodontal disease. Dent. Update, 46(3), 257–265. https://doi.org/10.12968/denu.2019.46.3.257

Aslan, S., & Buduneli, N. (2019). Entire Papilla Preservation Technique With and Without Biomaterials in the Treatment of Isolated Intrabony Defects. Case Med. Res. https://doi.org/10.31525/ct1-nct03923465

Aslan, S., Buduneli, N., & Cortellini, P. (2017a). Entire Papilla Preservation Technique: A Novel Surgical Approach for Regenerative Treatment of Deep and Wide Intrabony Defects. Int. J. Periodontics Restorative Dent. https://doi.org/10.11607/prd.2584

Aslan, S., Buduneli, N., & Cortellini, P. (2017b). Entire papilla preservation technique in the regenerative treatment of deep intrabony defects: 1-Year results. J. Clin. Periodontol. https://doi.org/10.1111/jcpe.12780

Aslan, S., Buduneli, N., & Cortellini, P. (2020). Clinical outcomes of the entire papilla preservation technique with and without biomaterials in the treatment of isolated intrabony defects: A randomized controlled clinical trial. J. Clin. Periodontol., 47(4), 470–478. https://doi.org/10.1111/jcpe.13255

Citterio, F., Gualini, G., Chang, M., Piccoli, G. M., Marta Giraudi, Manavella, V., Baima, G., Mariani, G. M., Romano, F., & Aimetti, M. (2022). Pocket closure and residual pockets after non-surgical periodontal therapy. A systematic

review and meta-analysis. J Clin Periodontol, 49(1), 2–14. https://doi.org/10.1111/jcpe.13547

Clementini, M., Ambrosi, A., Cicciarelli, V., De Risi, V., & de Sanctis, M. (2019). Clinical performance of minimally invasive periodontal surgery in the treatment of infrabony defects: Systematic review and meta-analysis. J. Clin. Periodontol., 46(12), 1236–1253. https://doi.org/10.1111/jcpe.13201

Cortellini, P, & Tonetti, M. (2007). A minimally invasive surgical technique with an enamel matrix derivative in the regenerative treatment of intra-bony defects: A novel approach to limit morbidity. J. Clin. Periodontol. https://doi.org/10.1111/j.1600-051X.2006.01020.x

Cortellini, Pierpaolo, & Tonetti, M. S. (2009a). Improved wound stability with a modified minimally invasive surgical technique in the regenerative treatment of isolated interdental intrabony defects. J. Clin. Periodontol. https://doi.org/10.1111/j.1600-051X.2008.01352.x

Cortellini, Pierpaolo, & Tonetti, M. S. (2009b). Improved wound stability with a modified minimally invasive surgical technique in the regenerative treatment of isolated interdental intrabony defects. J. Clin. Periodontol., 36(2), 157–163. https://doi.org/10.1111/j.1600-051X.2008.01352.x

Cortellini, Pierpaolo, & Tonetti, M. S. (2011). Clinical and radiographic outcomes of the modified minimally invasive surgical technique with and without regenerative materials: A randomized-controlled trial in intra-bony defects. J. Clin. Periodontol. https://doi.org/10.1111/j.1600-051X.2011.01705.x

Cortellini, Pierpaolo, & Tonetti, M. S. (2015). Clinical concepts for regenerative therapy in intrabony defects. Periodontol. 2000, 68(1), 282–307. https://doi.org/10.1111/prd.12048

Cortellini, Pierpaolo. (2012). Minimally invasive surgical techniques in periodontal regeneration. J. Evid. Based. Dent. Pract. https://doi.org/10.1016/S1532-3382(12)70021-0

Ethan, N., Tay, J. R. H., & Ong, M. M. A. (2021). "Minimally Invasive Periodontology: A Treatment Philosophy and Suggested Approach." Int. J. Dent., 2021, 2810264.

Harrel, S. K. (1999). A Minimally Invasive Surgical Approach for Periodontal Regeneration: Surgical Technique and Observations. J. Periodontol., 70(12), 1547–1557.

Kim, C.-S., Choi, S.-H., Chai, J.-K., Cho, K.-S., Moon, I.-S., Wikesjö, U. M. E., & Kim, C. K. (2004). Periodontal Repair in Surgically Created Intrabony Defects in Dogs: Influence of the Number of Bone Walls on Healing Response. J Periodontol, 75(2), 229–235.

Kiyak, H. A., Hohl, T., West, R. A., & McNeill, R. W. (1984). Psychologic Changes in Orthognathic Surgery Patients: J. Oral Maxillofac. Surg., 42, 506–512. https://doi.org/10.1016/0278-2391(84)90009-0

Klein, F., Kim, T. S., Hassfeld, S., Staehle, H. J., Reitmeir, P., Holle, R., & Eickholz, P. (2001). Radiographic defect depth and width for prognosis and description of periodontal healing of infrabony defects. J Periodontol, 72(12), 1639–1646.

Nibali, Luigi, Koidou, V. P., Nieri, M., Barbato, L., Pagliaro, U., & Cairo, F. (2020). Regenerative surgery versus access flap for the treatment of intra-bony periodontal defects: A systematic review and meta-analysis. J. Clin. Periodontol., 47(S22), 320–351. https://doi.org/10.1111/jcpe.13237

Papapanou, P., Sanz, M., Buduneli, N., Dietrich, T., Feres, M., Fine, D. H.,

Flemmig, T. F., Garcia, R., Giannobile, W. V., Graziani, F., Greenwell, H., Herrera, D., Kao, R. T., Kebschull, M., Kinane, D. F., Kirkwood, K. L., Kocher, T., Kornman, K. S., Kumar, P. S., Loos BG, Machtei E, Meng H, Mombelli A, Needleman I, Offenbacher S, Seymour GJ, Teles R, Tonetti, M. S. (2018). Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. J. Periodontol., 89(March), S173–S182. https://doi.org/10.1002/JPER.17-0721

Papapanou, Panos N., & Tonetti, M. S. (2000). Diagnosis and epidemiology of periodontal osseous lesions. Periodontol. 2000. 22:8-21. doi: 10.1034/j.1600-0757.2000.2220102. x.

Shukla, S., Chug, A., Mahesh, L., Singh, S., & Singh, K. (2019). Optimal management of intrabony defects: Current insights. Clin. Cosmet. Investig. Dent., 11, 19–25.

Sultan, N., Jafri, Z., Sawai, M., & Bhardwaj, A. (2020). Minimally invasive periodontal therapy. J. Oral Biol. Craniofacial Res., 10(2), 161–165. https://doi.org/10.1016/j.jobcr.2020.04.014

Tomasi, C., Leyland, A. H., & Wennström, J. L. (2007). Factors influencing the outcome of non-surgical periodontal treatment: a multilevel approach. 682–690. https://doi.org/10.1111/j.1600-051X.2007.01111.x

Tonetti, M., Greenwell, H., & Kornman, K. S. (2018). Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. J. Periodontol.

Tonetti, Maurizio S., Fourmousis, I., Suvan, J., Cortellini, P., Brägger, U., & Lang, N. P. (2004). Healing, post-operative morbidity and patient perception of outcomes following regenerative therapy of deep intrabony defects. J. Clin. Periodontol., 31(12), 1092–1098. https://doi.org/10.1111/j.1600-051X.2004.00615.x

Vandana, K., & Chandra, G. B. (2017). Periodontal Osseous Defects: A Review. CODS J. Dent., 9(1), 22–29. https://doi.org/10.5005/jp-journals-10063-0028

Zuhr, O., Akakpo, D. L., & Hürzeler, M. (2017). Wound closure and wound healing. Suture techniques in contemporary periodontal and implant surgery: Interactions, requirements, and practical considerations. Quintessence Int 20;647-660

Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). Get vaccinated when it is your turn and follow the local guidelines. International Journal of Health Sciences, 5(3), x-xv. https://doi.org/10.53730/ijhs.v5n3.2938

Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). Health and treatment of diabetes mellitus. International Journal of Health Sciences, 5(1), i-v. https://doi.org/10.53730/ijhs.v5n1.2864

Djuraev, A. M., Alpisbaev, K. S., & Tapilov, E. A. (2021). The choice of surgical tactics for the treatment of children with destructive pathological dislocation of the hip after hematogenous osteomyelitis. International Journal of Health & Medical Sciences, 5(1), 15-20. https://doi.org/10.21744/ijhms.v5n1.1813