Minimally Invasive Surgery Periodontal Therapy for the Treatment of Intrabony Periodontal Defects: A Systematic Review

Abstract

Background: Minimally invasive therapeutic approaches have become the standard of care for many medical procedures. Conventional periodontal surgical therapies involve extensive tissue reflection, resulting in increased morbidity which stands to reason out that Minimally invasive surgery (MIS) approach for periodontal therapy would result in less morbidity and better esthetics for the patient. Thus, the aim of this review is to assess the clinical efficacy of MIS periodontal therapy compared to conventional access flap surgery for the treatment of intrabony periodontal defects. **Materials and Methods:** An electronic and manual search was done to identify and collect studies evaluating MIS periodontal therapy for the treatment of intrabony periodontal defects in terms of periodontal probing depth (PPD) reduction, clinical attachment level (CAL) gain, and gingival recession (REC) with a minimum of 6 month follow-up published in English. Six studies which satisfied the inclusion criteria were included for the review and the data extracted. **Results:** The six included studies contributed to a total of 193 patients who underwent 93 MIS therapies for treating intrabony defects with at least a 6-month follow-up. Clinical evaluation showed a PPD reduction ranging from 3.55 ± 0.88 mm to 5.2 ± 1.6 mm, while CAL gain ranged from 2.82 ± 1.19 mm to 4.5 ± 1.1 mm, while the change in gingival margin level ranged from 0.06 mm to 0.5 mm. Only one study directly compared single flap approach (SFA) (a type of MIS) to double flap approach (papilla preservation flap) which reported PPD reduction and CAL gain to be better in SFA. **Conclusion:** Even though the above evidence compels us to believe that minimally invasive periodontal surgery is less invasive, less time consuming, and less morbid, the lack of enough studies directly comparing MIS with conventional access flap surgeries suggest that these conclusions are arbitrary. Thus, there is currently an absence of adequate evidence to substantiate the beneficial effect of minimally invasive periodontal surgical approach compared to a conventional access flap surgery for the treatment of intrabony periodontal defects.

Keywords: *Minimally invasive, periodontal regeneration, periodontal surgery*

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Introduction

Nowadays, there is an increase in early recognition of periodontal disease as compared to the past. In addition to this, the delivery of extensive nonsurgical treatment before referral for surgical treatment results in a patient usually presenting with isolated rather than generalized periodontal disease sites.[1] However, even these isolated diseased sites are treated with the conventional periodontal flap surgical techniques, involving relatively longer incision and extending into adjacent periodontally noninvolved areas that were designed for the treatment of generalized disease.[2] Even though the objective of these extensive tissue reflections were to increase the visibility and accessibility of the surgical area, it ultimately results in additional attachment loss.[3-5] which can lead to morbidities such as thermal sensitivity, food impaction, and compromised esthetics.[6] In recent years, with clinical innovation in flap design and handling, addressing only the periodontally involved sites has become possible, resulting in a drastic reduction of wound failure when compared to conventional flap approach.[7] Thus, it stands to reason out that a reduced access surgical site or minimally invasive approach would result in less morbidity and better esthetics for the patient.[8]

In medicine, the term "minimally invasive surgery (MIS)" was first coined by general surgeons Fitzpatrick and Wickham in

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1990.[9] which was further explored by Hurter and Sackier in 1993.[10] They defined MIS as the ability to perform a traditional surgical procedure and achieve the same or better outcomes utilizing a surgical opening that was smaller than traditional surgical access.[8] This small surgical incision results in less postoperative discomfort, more rapid healing, less morbidity, and equal or improved long-term surgical outcomes. Accessibility to these sites with smaller incisions was made possible with the advancement in technology. These procedures were initially described by the instrument used to perform it. for example laparoscopic surgery or microsurgery. However, finally, the need for noninstrument-based description of surgical procedure was recognized and those surgical procedures using smaller incision were now described as minimally invasive surgeries.[8]

MIS for periodontal therapy was introduced by Harrel in 1998,[3] with the objectives of minimal mesiodistal extension of periodontal flap, minimal flap elevation to expose only 1–2 mm of alveolar bone, to avoid the placement of vertical incision but if necessary confined within attached gingiva and not extending beyond mucogingival junction, and to avoid periosteal incision.[1] Following this, many MIS procedures such as minimally invasive surgical technique (MIST),[11] modified MIST (M-MIST),[7,12,13] and single flap approach (SFA)[14] were developed with modifications from the basic technique proposed by Harrel, claiming to reduce morbidity and enhance clinical outcome when treating periodontal pockets.

Many of the published reports in the past decade have evaluated MIST for the treatment of intrabony periodontal defects which involves a flap design with minimal incision and elevation that is adequate enough to access the defect under magnification.[15,16] Such flap designs are thought to have the advantage of reduced surgical trauma and creating a contained surgical wound that preserves the blood clot all of which could result in an early and enhanced wound healing. Similarly, in SFA technique first reported in 2007 by Trombelli *et al*., involved elimination of bilateral flap reflection, when pockets are confined to a single side, thus eliminating the involvement of nondiseased sites.[17,18]

However, the effectiveness of these minimally invasive periodontal surgical procedures remains to be clarified in terms of clinical performance and patient perception and the benefits when compared to more traditional flap approaches. This systematic review aims to assess the available evidence for clinical effectiveness and benefits of MIS periodontal therapy in treating periodontal intrabony defects.

Materials and Methods

Protocol development

The study protocol was designed according to the Preferred Reporting Items Systematic Review and Meta-Analyses statement,[19] in order to systematically review the literature regarding MIS periodontal therapy for intrabony periodontal defects. The focused question of this review was what is the clinical efficacy of MIS periodontal therapy for the treatment of intrabony periodontal defects when compared to conventional access periodontal flap surgeries. The evidence was evaluated with two objectives (1) to assess the clinical effectiveness of minimally invasive periodontal surgery for the treatment of intrabony periodontal defects and (2) to compare it with conventional access flap surgery.

Eligibility criteria

The eligibility criteria for study selection were based on the PICO method and were the following:

(P) Type of Participants: Periodontitis patients presenting with clinically or radiographically detectable intrabony defects with periodontal pockets not resolved after nonsurgical periodontal therapy.
(I) Type of Interventions: MIS approach, MIST, M-MIST, and SFA for treating intrabony periodontal defects.
(C) Comparison: Conventional access flap surgery for treating intrabony periodontal defects.
(O) Outcome measures: Primary outcome was clinical attachment level (CAL) gain and periodontal probing depth (PPD) reduction. Secondary outcomes were changes in gingival margin level (REC).

Information sources and search

The following online databases were searched for the relevant articles – PubMed, European PMC, Science Direct, and Google Scholar. The search was done using both MeSH terms and text words. The search strategy carried out in PubMed database is as follows,

(((((((((periodontitis) AND (intrabony defect)) OR (alveolar defect)) OR (alveolar bone loss)) OR (angular defect)) AND (dental)) AND (clinical attachment loss)) OR (probing depth)) OR gingival recession AND (Minimally invasive surgery) AND ((clinical trial[Filter] OR randomized controlled trial[Filter]) AND (y_10[Filter])) AND ((clinical trial[Filter] OR randomized controlled trial[Filter]) AND (y_10[Filter])).

In addition to this, a manual hand search was also done in specialty journal such as Journal of Clinical Periodontology, Journal of Periodontology, Clinical Oral Investigations, The International Journal of Periodontics and Restorative Dentistry and Journal of Periodontal Research, and Journal of Periodontal Implant Sciences. The references of included studies were also checked for relevant possible studies, and the authors were contacted to get additional information.

Inclusion criteria

Only randomized controlled clinical trials in human published in English language and with at least 6 months of follow-up were considered. Furthermore, only published articles between May 2010 and May 2020 were included in

the review process. MIS therapy was considered only when preservation of interdental soft tissue, limited mesiodistal extension of the flap, and no use of vertical incisions was clearly mentioned in the text by the author, and data regarding the use of applying specific instrumentations under magnification system are given.

Exclusion criteria

Studies published before May 2010, studies with incomplete data, case reports, and case series were excluded from the review.

Study selection

The titles and abstracts of studies were first screened independently by two review authors (TM and SN). For the studies satisfying the inclusion criteria, but with insufficient data in the abstract, full text data were reviewed. Then, the shortlisted articles are subjected to a full text review process to further narrow down to studies that meet the inclusion criteria. For all the included studies, a validity assessment was done, and duplicates were removed at this stage [Figure 1].

Data collection process

From the finally shortlisted studies, the two reviewers independently extracted the data from the full text of the articles using specifically designed customized piloted forms. The data such as title of the included study, author and year of publication, study design, number and details of treatment groups, number of patients, follow-up period, mean age, gender, PPD, CAL, and REC changes for the included studies were extracted and summarized in Table 1.

Outcome measures

CAL gain, PPD reduction, and REC given as the mean difference between baseline and follow-up of the treated sites in millimeters.

Search results

The combined electronic and manual research conducted based on search strategy yielded seventy nonduplicate papers which were reduced to ten papers after the eligibility process based on title and abstract excluded 60. Four articles were excluded on the basis of the exclusion criteria, while the remaining six articles fulfilled the inclusion criteria and were processed for data extraction [Figure 1].

Study design and follow-up

Of the selected studies, all were randomized clinical trials (Ribeiro *et al*., Mishra *et al*., Cortellini *et al*., Trombelli *et al*., Ahmad *et al*., and Aimetti *et al*.)[7,11-14,20] with a parallel design. Follow-up periods ranged between 6 months and 12 months.

Population

The studies included had a number of participants ranging between 24 and 45. Only one study did not report any mean age of patients (Mishra *et al*.), while all others had a range from 34 ± 6.8 to 55.6 ± 5.9 years. Gender

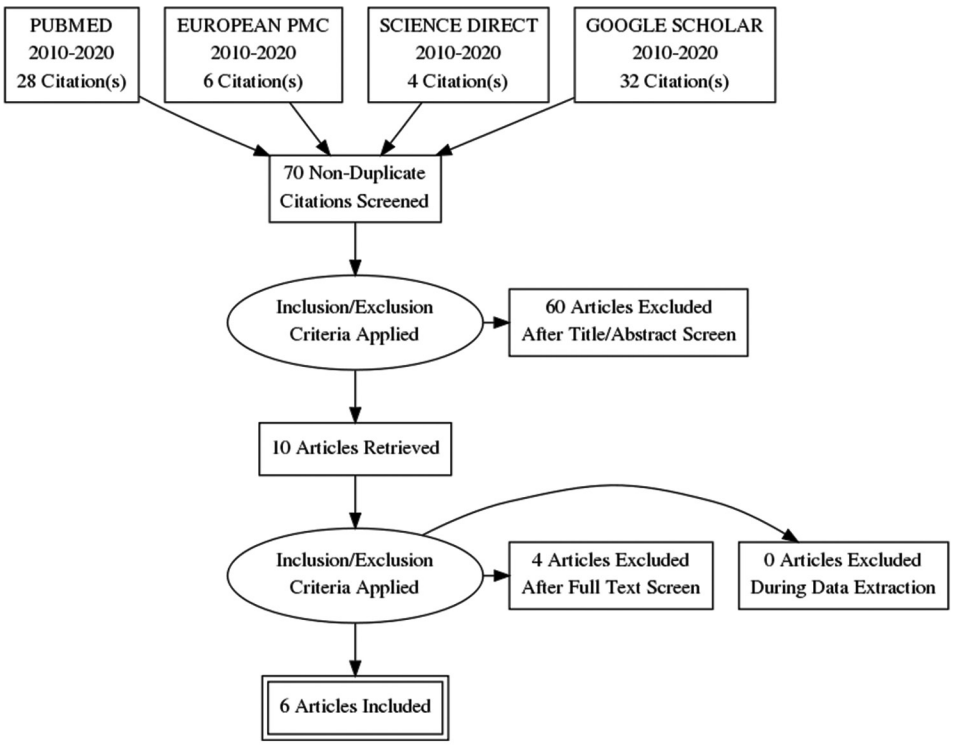

Figure 1: Flow diagram (Preferred Reporting Items Systematic Review and Meta-Analyses format) of the screening and selection process

Table 1: General characteristics and clinical outcomes of included studies

Study included	Author name and year of publication	Study design	Treatment groups	Patients	Follow-up period (months)	Mean age±SD (years)	Gender	PD		
								At baseline	At follow up	Reduction
1	Ashank Mishra *et al*. (2013)	RCT	M-MIST (CG) M-MIST + rhPDGF BB (TG)	24	6	Unclear	12 male/12 female	M-MIST (7.64±0.67) M-MIST + rhPDGF BB (7.73±1.19)	M-MIST (3.82±0.87) M-MIST+rhPDGF BB (4.18±0.60)	-
2	Pierpaolo Cortellini *et al*., (2011)	RCT	M-MIST (CG) M-MIST + EMD (CG) M-MIST+EMD+BMDX (TG)	45	12	M-MIST (48.9±7.9) M-MIST+EMD (34±5.9) M-MIST+EMD+ BMDX (47.2±8.5)	30 male/15 female	M-MIST (7.5±1.6) M-MIST+EMD (7.8±0.9) M-MIST+EMD+BMDX (7.3±1.2)	M-MIST (3.1±0.6) M-MIST+EMD (3.4±0.6) M-MIST+EMD+BMDX (3.3±0.6)	-
3	Leonardo Trombelli *et al*., (2012)	RCT	DFA (CG) SFA (TG)	28	6	SFA (55.1±6.8) DFA (42.9±6.6)	17 male/11 female	SFA (8.7±1.7) DFA (7.4±1.2)	SFA (3.5±0.8) DFA (3.5±0.9)	SFA (5.2±1.6) DFA (3.9±1.1)
4	Nabila Ahmad *et al*., (2019)	RCT	M-MIST (CG) M-MIST+PRF (TG)	36 (−4)	6	M-MIST (37.75±8.38) M-MIST + PRF (33.06±6.62)	19 male/13 female	M-MIST (7.06±0.92) M-MIST + PRF (7.50±0.73)	-	M-MIST (4.18±0.98) M-MIST+ PRF (12±0.95)
5	Fernanda V. Ribeiro *et al*., (2011)	RCT	MIST (CG) MIST+EMD (TG)	30	6	MIST (45.53±6.56) MIST + EMD (48.14±7.04)	11 male/19 female	MIST (7.12±1.10) MIST + EMD (7.09±1.70)	MIST (3.57±0.81) MIST+EMD (3.53±1.12)	MIST (3.55±0.88) MIST + EMD (3.56±2.07)
6	Mario Aimetti *et al*., (2017)	RCT	Flapless approach MIST–SFA (or) M-MIST	30	24	Flapless (44.3±8.1) SFA (or) M-MIST (42.2±6.1)	18 male/12 female	Flapless (7.5±0.9) SFA (or) M-MIST (7.3±0.8)	Flapless (3.9±0.9) SFA (or) M-MIST (3.6±0.9)	Flapless (3.6±1.0) SFA (or) M-MIST (3.7±0.6)

Study included	CAL			REC		
	At baseline	At follow up	Gain	Baseline	Follow up	Increase
1	M-MIST (6.91±0.70) M-MIST + rhPDGF BB (7.36±1.28)	M-MIST (2.64±0.67) M-MIST + rhPDGF BB (3.00±0.89)	-	M-MIST (0±0.0) M-MIST + rhPDGF BB (0.18±0.40)	-	M-MIST (−0.55±0.52) M-MIST + rhPDGF BB (−0.82±0.60)
2	M-MIST (9.6±2.0) M-MIST+EMD (9.9±1.3) M-MIST+EMD+BMDX (10.1±2.4)	M-MIST (5.5±1.6) M-MIST + EMD (5.7±1.7) M-MIST + EMD + BMDX (6.4±2.4)	-	M-MIST (2.1±1.4) M-MIST+EMD (2.1±1.4) M-MIST+EMD+BMDX (2.9±1.8)	M-MIST (2.4±1.4) M-MIST + EMD (2.3±1.4) M-MIST + EMD + BMDX (3.1±2.1)	-
3	SFA (9.4±2.1) DFA (8.4±1.7)	SFA (4.9±1.6) DFA (4.9±1.8)	SFA (4.5±1.1) DFA (3.4±1.4)	SFA (0.7±0.8) DFA (0.9±1.0)	SFA (1.4±1.2) DFA (1.4±1.7)	SFA (0.7±0.8) DFA (0.5±1.1)

Table 1: Contd...

Study included	CAL			REC		
	At baseline	At follow up	Gain	Baseline	Follow up	Increase
4	M-MIST (6.39±0.92)	M-MIST (4.00±1.09)	-	M-MIST (6.81±1.04)		M-MIST (0.06±0.25)
	M-MIST+PRF (6.52±0.68)	M-MIST+PRF (4.062±1.06)		M-MIST + PRF (6.87±0.71)		M-MIST + PRF (0.06±0.25)
5	MIST (11.03±1.91)	MIST (8.21±1.74)	MIST (2.82±1.19)	MIST (3.93±1.46)	MIST (4.47±1.52)	MIST
	MIST + EMD (12.23±2.03)	MIST + EMD (9.21±2.46)	MIST + EMD (3.02±1.94)	MIST + EMD (5.28±1.90)	MIST + EMD (5.74±1.88)	(0.54±0.58) MIST + EMD (0.46±0.87)
6	Flapless (9.4±2.0)	Flapless (6.2±2.3)	Flapless (3.2±1.1)	Flapless (1.9±1.8)	Flapless (2.3±2.6)	Flapless
	SFA (or) M-MIST (9.0±1.7)	SFA (or) M-MIST (5.4±1.6)	SFA (or) M-MIST (3.6±0.9)	SFA (or) M-MIST (1.7±1.2)	SFA (or) M-MIST (1.8±1.0)	(−0.4±0.7) SFA (or) M-MIST (−0.1±0.5)

MIST: Minimally invasive surgical technique, M-MIST: Modified MIST, SFA: Single flap approach, DFA: Double flap approach, PD: Probing depth, CAL: Clinical attachment level, Relative CAL: Stent to bottom of the pocket, Rec: Gingival recession, CG: Control group, TG: Test group, EMD: Enamel matrix derivative (Emdogain Institute Straumann AG), BMDX: Bone mineral derived xenograft (BioOss, Geistlich), rh PDGF BB: Recombinant human platelet-derived growth factor – BB, PRF: Platelet rich in fibrin; SD: Standard deviation

distribution was another variable with only one study showing gender-matched case and control groups (12 males and 12 females) (Mishra *et al*.).

Interventions and defect characteristics

All the 6 included studies have assessed one of the MIS procedures described in literature. Among these, one study compared MIST with and without emdogain (EMD), three studies compared M-MIST with and without different biomaterials (EMD/recombinant human platelet-derived growth factor BB [rhPDGF BB] gel/bone mineral derived xenograft [BMDX]/platelet-rich fibrin [PRF]), one study evaluated the MIST with a novel flapless surgical approach in addition to EMD and the rest one study evaluated SFA compared to a double flap approach (DFA).

All the selected study had reported the defect characteristic of having PD and CAL ≥5 mm and radiographic evidence of an intrabony defect of depth ≥3 mm except for one study (Cortellini *et al*., 2011).

Outcomes

All studies assessed PPD reduction, CAL gain and change in gingival margins level (Recession). Data regarding clinical measurements (PPD reduction, CAL gain, and REC change) were extracted from selected studies and described in Table 1.

Assessment of quality

Two review authors (TM and SN) performed the quality assessment of the included studies using the RevMan 5 software. Seven main quality criteria were examined: sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessors, incomplete outcome data and selective outcome reporting and others for individual studies [Figure 2], and for the outcomes [Figure 3]. Out of five studies assessed, two studies showed low risk of bias (Mishra *et al*. 2013, Trombelli *et al*. 2012), two studies have high risk of Bias (Ahmad 2019, Cortellini *et al*. 2011), and two studies have unclear risk of bias (Ribeiro *et al*. 2011, Aimetti *et al*. 2017).

Discussion

The primary objective of this study was to investigate the clinical effectiveness of MIS periodontal therapy in treating intrabony defects. In all the six studies, there was an evident improvement in the clinical parameters such as PPD reduction, and CAL gain. The mean PPD reduction in the studies ranged from 3.5 mm to 5.2 mm after a 6–12-month follow-up. This is similar to the reports by earlier study where they have observed around 4.18 mm of mean PPD reduction using MIS periodontal therapy.[21,22] This PPD reduction reported should be considered beneficial when compared to the PPD reductions from conventional access flap surgery since MIS reduces the surgical wound

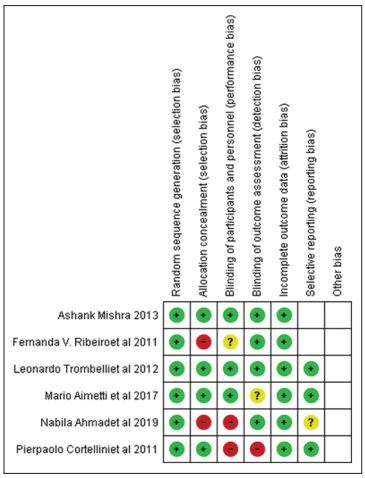

Figure 2: Risk of bias summary for each included study

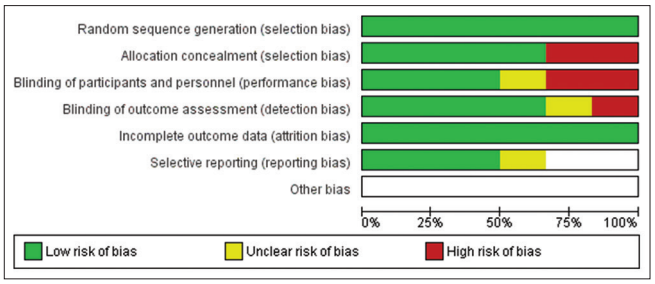

Figure 3: Risk of bias graph presented as percentages across all included studies

area, reduced operative time, all resulting in a minimal postoperative morbidity, and better patient comfort that ultimately enhances the clinical outcomes.

With respect to CAL gain, the studies reported a range from 2.8 mm to 4.5 mm which is again concurrent with previous reports,[21,22] and in one particular study[14] reporting CAL gain more than that obtained in some of the conventional access surgical approaches.[23,24] Another significant finding in most of the studies included here[7,11-14] and reported earlier are that the addition of any of the regenerative material such as EMD/rhPDGF BB gel/BMDX/PRF did not improve the attachment gain obtained with MIS periodontal therapy alone for the treatment of intrabony periodontal defects. These findings may suggest that the MIS periodontal therapy as a standalone procedure has the potential for intrinsic healing, by stabilizing blood clot, flap margin vascular perfusion due to minimal trauma and maintains a contained space due to minimal flap reflection and preservation of papillary architecture, which all increases the regenerative potential of the surgical wound.[25]

The change in gingival marginal levels (REC) ranged from 0.06 mm to 0.5 mm which is concurrent with earlier reports with MIS.[21,25] However, some reports in our included studies are similar to that reported in conventional flap approaches. Thus, it may suggest that more than the preservation of supracrestal papillary tissue, the change in gingival margin levels are contributed by postoperative tissue shrinkage.

Even though better clinical outcomes are observed with minimally invasive periodontal surgical protocol, the shorter period of follow-up in included studies (maximum 12 months) is considered a limitation. Studies with longer follow-up with larger sample size and homogeneity in defect characteristics and surgical design should be done to extrapolate these findings. Furthermore, the need for a very intense training programs and the use of magnification tools for practitioners which adds to the cost of the treatment should be weighed against the clinical benefits obtained in terms of PPD reduction, CAL gain, reduced REC, reduced operative time with minimal discomfort to patient while treating periodontal intrabony defects.

The second objective of the study was to compare the clinical efficacy of minimally invasive periodontal surgical therapy with conventional access flap surgery in treating intrabony defects. Our search resulted in only one article that satisfied the inclusion criteria, which compared SFA with conventional DFA for treating intrabony defects.[14] The observation of the study showed that the SFA group was similarly effective when compared to the DFA in terms of CAL gains and PPD reductions. There was only one study (Schincaglia *et al*. 2015) similar to this,[22] which compared a SFA combined with rhPDGF-BB + b-TCP to DFA with rhPDGF-BB + b-TCP. The observations showed that the SFA resulted in similar clinical outcomes to DFA, with better quality of early wound healing, and lower pain and consumption of analgesics during the first postoperative days compared to the DFA. Furthermore, these results are better than the results observed in a systematic review on access flap surgery which reported a 2.8 mm PPD reduction while treating intrabony defects at 12-month follow-up.[26,27]

Conclusion

Even though the above evidence is compelling to believe that minimally invasive periodontal surgery is less invasive, less time consuming, and less morbid, the lack of enough studies directly comparing MIS with conventional access flap surgeries may suggest these conclusions are arbitrary. Thus, our results show that MIS seems to be less time consuming, minimally invasive, and less morbid. However, currently, there is the absence of enough evidence to substantiate the beneficial effect of minimally invasive periodontal surgical approach compared to a conventional access flap surgery for the treatment of intrabony periodontal defects.

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Conflicts of interest

There are no conflicts of interest.

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