Effect of full sulcular versus papilla-sparing flap on periodontal parameters in periradicular surgeries: A systematic review and meta-analysis

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INTRODUCTION

Endodontic surgery can salvage teeth exhibiting failed root canal treatment, especially when these teeth are not amenable to be conserved with orthograde treatment alone.[1] One of the main goals of surgical endodontics is to eliminate periradicular pathology and thus promote periapical healing. This is achieved by sealing the root canal space apically as well as coronally.[2] For gaining access to the apical third of the tooth, a surgical flap is usually raised followed by osteotomy.[3] The design of flap bears an important role in the periradicular surgery. A number of clinical and radiographic parameters influence selection of flap design. These include site and size of the periapical lesion, level of existing restoration margins, gingival biotype, patient’s esthetic demands, and periodontal conditions of the teeth in question and the status of the adjacent teeth.[4,5] In contemporary dentistry, the goal of successful periradicular surgery is not just the functional retention of teeth but also to achieve optimal pink esthetics.[2,3] The term pink esthetics denotes that the appearance, color, texture, papilla height, and gingival position of the neighboring soft tissues should appear natural and healthy.[4] Various flap designs have been recommended in the literature. These include marginal incision, submarginal incision, and combination of both.

Abstract:
Background: Access to apical root canal system is gained after flap elevation using various incision techniques. Soft-tissue healing after periradicular surgery may include gingival recession, papilla recession, changes in probing depth, and clinical attachment loss. Objective: The objective of this study was to compare the effect of full sulcular flap design versus papilla-sparing flap design on the periodontal parameters in periradicular surgeries. Materials and Methods: It was a systematic review and meta-analysis. Electronic and manual searches were conducted in multiple databases including PubMed, Dental and Oral Sciences, Cochrane, and CINAHL Plus until May 2019. Initial search yielded 2575 studies with 5 articles meeting the inclusion criteria. The primary outcomes assessed were gingival recession and change in the papilla height. The secondary outcomes evaluated were probing depth, clinical attachment loss, postoperative pain, bleeding, and discomfort. Random-effects model was employed for computation of effect size, and forest plots were made. Results: Out of the five articles that satisfied the inclusion criteria, three were randomized control trials and two were nonrandom trials. No significant differences were found in the gingival recession (P = 0.79), papilla height (P = 0.55), gingival bleeding, and plaque indices. Statistically significant differences in probing depth (P = 0.006) and clinical attachment loss (P = 0.0004) were observed for the two flap designs in probing depth (P = 0.006) and clinical attachment loss (P = 0.0004). Conclusions: The present systematic review and meta-analysis showed that probing depth and attachment loss are affected by the choice of flap design. On the other hand, gingival recession and papilla height are not influenced by the type of incision. However, finding of the present review may change if more studies on this topic will be included in the future. Therefore, more clinical trials with long-term follow-ups are needed.

Key words: Apicectomy, endodontic surgery, full sulcular flap, intrasulcular incision, papilla-based incision, papilla-sparing flap, periodontal parameters

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Marginal incision involves raising a full-thickness sulcular flap (FSF) of any design with or without a vertical releasing incision. The submarginal flaps can be semilunar in shape or with a scalloped design also known as Ochsenbein-Luebke flap.[2] There is another flap which is a combination of marginal and submarginal incision named as “papilla-sparing flap or papilla-based incision” (PSF). It spares the papilla base in the interdental zone and becomes a sulcular incision in the cervical area of the involved teeth.[3] The choice of incision largely depends on the size of the lesion, site of surgery, amount of keratinized tissue, and above all training and preference of the clinician. Gingival recession including changes in papilla height and scar tissue formation are frequent consequences noticed due to not adhering to the basic principles of flap elevation.[4]

The benefits of PSF as suggested in the literature are as follows: less gingival recession, reduced chances of papillary height loss, and reduced likelihood of scarring. It also guarantees a large surgical area exposure without having to pull the flap, thus permitting convenient access in performing peri-radicular surgery on long roots.[5] On the other hand, submarginal flaps warrant specific criteria and can only be employed in areas where there is availability of optimum amount of keratinized tissue,[6] whereas the FSF and PSF can be used in all sites irrespective of availability of optimum tissue thickness.[7]

Studies have reported variable outcomes when FSF incision is compared to PSF. A study by Velvart et al. reported that FSF technique resulted in significant gingival recession and loss of papilla height when compared to PSF,[8] whereas another study by Tascheri et al. reported that there is no difference in the outcomes of the two techniques on gingival margins and papilla height.[9]

There is lack of consensus in the reported literature regarding the effects of FSF and PSF on the periodontal parameters. Few studies documented the supremacy of FSF, whereas others favored PSF design. Most studies exhibited no difference in these two approaches. For the above rationale, our objective was to explore which of the two flap designs is superior in terms of maintenance of periodontal parameters in periapical surgery.

MATERIALS AND METHODS

Protocol and registration
The review protocol was registered on an international database of prospectively registered systematic reviews named PROSPERO (CRD420180997480) to avoid any unintended repetition of the review on this subject. We firmly followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[10] Our review question was: “Which flap design of the two (full sulcular versus papilla-sparing incision) is better for the maintenance of periodontal parameters in periapical surgery. Reporting of results of this review was in accordance to the PRISMA statement and Cochrane Handbook for Systematic Reviews of Interventions.[11,12]

Eligibility criteria
The following PICOS model was used:

Participants were subjects undergoing periapical surgery. Intervention was PSF which was compared to full sulcular flap. Outcomes assessed were as follow: periodontal parameters, i.e., gingival recession, loss of papilla height, increase in probing depth, and clinical attachment loss. Studies: All the clinical trials (randomized and nonrandomized) in English language were included. Unpublished articles, single-arm longitudinal studies, reviews, case series, case reports, commentaries, and letters to the editor were excluded.

Search strategy
A broad literature search was executed from June 2000 to September 2019. Three major health science databases (EBSCO Dentistry and Oral Sciences Source, PubMed [NLM], and CINAHL Plus) were searched for randomized and nonrandomized clinical trials on incision design in radicular surgery. Medline, database for registered clinical trials (www.ClinicalTrials.gov), and Google Scholar were manually searched to ascertain any gray literature and unpublished data. MESH terms included different versions of: (esthetics OR gingiva OR gingival recession OR follow up OR apical surgery OR apicoectomy OR interdental papilla OR dental papilla OR periodontal index OR periodontal pocket OR periodontal attachment loss) AND (intra sulcular incision OR full sulcular flap OR papilla based incision OR papilla preservation flap OR papilla sparing flap OR submarginal flap OR Ochsenbein-Luebke incision).

Screening and data extraction
All the articles were initially reviewed by one of the authors to exclude any duplicated or irrelevant studies. On the basis of titles, abstracts, objectives, outcomes, study designs, and availability of full-text articles of the studies were evaluated individually by two investigators. Disagreements at any point were discussed with the third and fourth authors. Thoroughly evaluated articles were finally included in the systematic review, while others were excluded after detailed analysis with their corresponding reasons for exclusion. A customized proforma was developed and filled in with the data extracted from the finally included studies.

Risk of bias
Cochrane risk-of-bias assessment tool was used by three investigators separately to assess the quality of clinical trials.[12] The fourth author reviewed and resolved the conflicts after discussion with the other authors. The studies were allocated to high, low, or unclear risk of bias with the help of Cochrane risk-of-bias assessment tool.

Statistical analysis
Meta-analysis was executed using Review Manager Version 5.3.5 (The Nordic Cochrane Centre, the Cochrane Collaboration, Copenhagen, Denmark) for both qualitative and quantitative variables on the data from the included studies.[13] Random-effects model and fixed model were used as per heterogeneity of the studies to compute overall effect size. F statistic was used to evaluate the heterogeneity among the finally included studies. Pair-wise meta-analysis was executed for the main outcomes (gingival recession and papilla height) and secondary outcomes (probing depth and clinical attachment loss). The level of significance (α) was kept at ≤ 0.05.

RESULTS

Study selection
After comprehensive literature exploration, a total of 2575 studies were recognized. Initial scrutiny was carried out to...
eliminate irrelevant titles, objectives, duplicate studies, and studies other than English language. A total of 22 studies with relevant titles were further screened on the basis of inclusion criteria. Articles with irrelevant objective, no full text, protocols only, in vitro studies, and different study designs were excluded leaving only 5 studies for final review. The PRISMA flow diagram is shown in Figure 1. Articles that were excluded are mentioned in Table 1 with their respective reasons for exclusion.

**Study characteristics**

Out of 5 clinical trials, 3 were randomized trials and 2 were nonrandomized trials. A number of 283 participants were evaluated in the selected studies. Von Arx et al.\(^2\) contributed maximum number of patients (n = 184), whereas Sargolzaie et al.\(^{28}\) added data of 14 patients. The age range of the participants was between 18 and 63 years. However, von Arx et al.\(^2\) did not mention the age range of their participants.

Most studies did not report gender distribution of patients except Del Fabbro et al.\(^{29}\) The minimum follow-up was of 1 month\(^2\) and the maximum follow-up was of 1 year.\(^{2,9,28}\) The control group in all the studies was FSF [Table 2]. The variables assessed in the included studies are mentioned in Table 3.

**Outcomes of included studies**

Out of all included studies, two reported no significant difference in the gingival recession in the two incision designs,\(^2,9\) whereas the other two studies favored PSF.\(^{8,28}\) Fifth study did not comment on this parameter [Table 3].

Three studies\(^{8,9,28}\) reported postoperative loss in papilla height, of which two studies supported PSF,\(^{8,28}\) whereas one study reported no significant difference between the two techniques.\(^9\)

Out of all studies, only two studies reported clinical attachment loss and change in probing depth.\(^{2,28}\) Only one study favored PSF, as it resulted in less clinical attachment loss,\(^2\) whereas both techniques were statistically similar with respect to change in probing depth.\(^2,28\) [Table 3]. There were few secondary outcomes reported. Those included bleeding index, gingival index, plaque scores, and postoperative pain.\(^{28,29}\) Only two studies reported effects of incision design on bleeding.\(^{2,24}\) Whereas gingival index, plaque index, and postoperative pain were reported by one study each. None of the outcomes were found to be significantly associated with the incision design except postoperative pain which was reported to be less with the selection of PSF\(^{29}\) [Table 3].

**Results of meta-analysis**

Meta-analysis was performed on four outcome variables. These were gingival recession, loss in papilla height, increase in the probing depth, and loss of clinical attachment. For gingival recession, Velvert et al. were excluded in the meta-analysis on the account of missing data,\(^9\) whereas for loss of papilla height, Taschieri et al. was excluded from the meta-analysis due to substantial heterogeneity in the reported data.\(^9\) All studies that reported probing depth and clinical attachment loss were included for the meta-analysis.\(^{2,28}\)

For the computation of summary effect of gingival recession and papilla height, random-effects model was used, whereas fixed model was employed for clinical attachment loss and probing depth. Out of four studies that reported recession, only three studies were subjected to meta-analysis.\(^{2,9,28}\) The result of meta-analysis showed that the risk of gingival recession in the FSF group was similar to PSF as the result was not statistically significant (risk ratio: 1.08; 95% confidence interval [CI], −0.22, 0.29) \(F = 63\%\), \(P = 0.07\) [Figure 2].

Out of three studies that reported loss in papilla height,\(^{2,9,28}\) only two studies were subjected to meta-analysis.\(^{8,28}\) The forest plot depicts that FSF and PSF were similar in affecting the papilla height. The result was not statistically significant (weighted mean difference: −0.38; 95% CI, −1.64, 0.87) \(F = 97\%\), \(P = 0.55\) [Figure 3].

There were two studies\(^{2,28}\) that reported an increase in probing depth. Both were included in the meta-analysis, and the outcomes exhibited that PSF exhibited less adverse effect on probing depth (weighted mean difference: 0.12; 95% CI, 0.03, 0.21) \(F = 0\%\), \(P = 0.006\) [Figure 4].

Likewise, there were two studies\(^{2,28}\) that reported loss in clinical attachment and both underwent meta-analysis. The results displayed that PSF is associated with significantly less clinical attachment loss (weighted mean difference: −0.24; 95% CI, −0.37, −0.11) \(F = 0\%\), \(P = 0.004\) [Figure 5].

**Risk of bias**

Cochrane’s collaboration tool was used to evaluate the risk of bias of final studies.\(^{11,12}\) Blinding of participants was not possible due to the sort of surgical involvement and inherent nature of the procedure used in the test and control groups. Thus, the highest risk of bias was reported for blinding of participants. Randomization was carried out in three out of five randomized clinical trials.\(^{28,29}\) The method of randomization was not clear in a study by Velvert et al. Allocation concealment was either unclear or entirely missing in all the studies except one study by Del Fabbro et al.\(^{29}\) Methods used for blinding of the outcome assessors were mentioned in two studies only.\(^{2,28}\) The attrition bias was nonexistent because no subjects in any of the involved studies failed to complete the trial. The authors adequately reported the outcomes under consideration in the studies. Other biases remained unclear. Details are given in Figures 6 and 7.

**DISCUSSION**

Flap design has an important effect on the outcome of any surgery, and periradicular surgery is no exception.\(^4\) The type and technique of the flap are affected by the size and site of apical lesion, periodontal conditions, associated anatomical structures, and operator’s expertise.\(^4\) There is a lack of high level evidence to endorse the best incision technique to have less postoperative periodontal complications.\(^8,9\) Even after thorough literature search, we failed to identify any systematic review on this topic.

We restricted our inclusion criteria to clinical trials only; three of the included studies were randomized clinical trial\(^{2,28}\) and two were nonrandomized.\(^{12,24}\) The method of randomization in clinical trials included was not reported except for one trial.\(^{29}\)

There were two studies which were clinical trials yet not included in this systematic review. One study was by Taschieri...
Table 1: Characteristics of excluded studies

| Author                   | Year  | Study type       | Reason for exclusion          |
|--------------------------|-------|------------------|------------------------------|
| Omar (2)                 | 2018  | Single arm       | Irrelevant objective         |
| Peharrocha Diago and Cervera Ballester (14) | 2017  | A review         | Irrelevant objective         |
| von Arx et al (10)       | 2012  | Observational cohort | Irrelevant objective          |
| Grandi and Pacifici (74) | 2009  | A review         | Irrelevant objective         |
| Kreiser et al (21)       | 2009  | Clinical observational study | Irrelevant objective          |
| von Arx et al (19)       | 2008  | Cohort           | Irrelevant objective         |
| Velvart and Peters (4)   | 2005  | Review           | Irrelevant objective         |
| Lieblich (16)            | 2015  | Review           | Study design                 |
| Verardi (20)             | 2012  | Letter to editor/review | Study design                 |
| von Arx (3)              | 2011  | Review           | Study design                 |
| Taschieri et al (22)     | 2009  | Cohort           | Study design                 |
| Von Arx and Salvi (22)   | 2008  | Review           | Study design                 |
| Velvart et al (24)       | 2004  | Single arm       | Study design                 |
| Velvart (25)             | 2002  | Single arm       | Study design                 |
| Velvart et al (26)       | 2003  | RCT              | Duplicate data               |
| Taschieri et al (27)     | 2014  | RCT              | Duplicate data               |

RCT – Randomized control trial
NRCT – Nonrandomized control trial; RCT – Randomized control trial; n – number of studies

Table 2: Characteristics of included studies

| n | Author                          | Journal                          | Study type | Year | Follow-up months | Sample size |
|---|---------------------------------|----------------------------------|------------|------|------------------|-------------|
| 1 | Taschieri et al.                | Journal of Endodontics           | NRCT       | 2016 | 12               | 21          |
| 2 | Sagolzaie et al.                | Journal of Dental Specialities   | RCT        | 2013 | 01               | 14          |
| 3 | Fabbro et al.                   | International Journal of Endodontics | RCT    | 2009 | 12               | 40          |
| 4 | Von Arx et al.                  | International Journal of Endodontics | RCT    | 2007 | 12               | 284         |
| 5 | Velvart et al.                  | International Journal of Endodontics | RCT    | 2004 | 12               | 24          |

NRCT – Nonrandomized control trial; RCT – Randomized control trial; n – number of studies

Table 3: Parameters evaluated in included studies with preference for either full sulcular versus papilla-sparing flap

| Author                      | Gingival recession | Papilla height | Clinical attachment loss | Probing depth | Bleeding | Gingival index | Plaque index | Postoperative pain |
|-----------------------------|--------------------|----------------|--------------------------|---------------|----------|----------------|--------------|-----------------|
| Taschieri et al.            | >0.05              | 0.048*         | 0.048*                   | -             | -        | -              | -            | -               |
| Both Papilla-sparing flap   | Both Papilla-sparing flap | -             | 0.85                     | >0.05         | Both     | -              | -            | -               |
| Fabbro et al.               | -                  | -              | -                         | >0.05         | Both     | <0.05*         | -            | -               |
| Both Papilla-sparing flap   | Both Papilla-sparing flap | -              | -                         | >0.05         | Both     | -              | -            | -               |
| Von Arx et al.              | >0.05              | <0.001*        | <0.001*                  | >0.05         | >0.05   | -              | -            | -               |
| Both PBI                    | Both PBI           | Papilla-sparing flap | Papilla-sparing flap | Both         | Both     | -              | -            | -               |
| Velvart et al.              | <0.001*            | 0.048*         | 0.048*                   | -             | -        | -              | -            | -               |
| Papilla-sparing flap         | Papilla-sparing flap | Papilla-sparing flap | Papilla-sparing flap | -            | -        | -              | -            | -               |

*P ≤ 0.05 is statistically significant. PSF – Papilla sparing flap; P – Level of significance

et al. who reported one article with 6-month follow-up followed by another article at a year follow-up. We included the article with a year follow-up. Hence, exclusion of article with less number of follow-up is to avoid overestimation of results. Same is the case in the study by Velvart et al (26).

Both of these incision techniques (FSP and PSF) are commonly used in periradicular surgery. Every incision technique has its own merits and demerits. The main disadvantage reported with the FSF is gingival recession and shrinkage of papilla height (8,28). The PSF was introduced by Velvart in 2002 to allow preservation of entire papilla, therefore, salvaging its height and integrity (25). Gingival recession is reported in 2005 A review of 4 out of 5 included studies in the present review (24,28,29) with 243 out of 283 patients exhibiting favorable outcomes in healing phase with less recession in gingival margin in the PSF group (28) whereas our meta-analysis did not support this notion and clearly showed that the type of incision has no significant adverse effect on the gingival margin. Loss of papilla height was reported in 3 out 5 studies (8,28,29) with 89 out of 283 patients having less detrimental effects on papilla height in the PSF group (8,28). However, the results of meta-analysis exhibited no significant difference in both techniques.

The effect of incision designs on probing depth and clinical attachment loss was reported by two out of five studies (2,28). Effect of incision on probing depth was not found to be significant in the reported data (8,28) whereas the forest plot in meta-analysis illustrated that PSF has less detrimental effects on the probing depth (P = 0.006).

As far as the effect of incision design on clinical attachment loss is concerned, out of two studies, only one (Von Arx et al.) was in favor of FSF (29). No difference in clinical attachment loss was reported by Sagolzaie et al. (29). The result of metaanalysis
were significantly in favour of PSF as significantly less clinical attachment loss was observed in PSF group as opposed to FSP group (\(P = 0.0004\)).

Despite of two studies reporting bleeding scores, they were not included in meta-analysis. Both studies used two different indices for scoring, i.e., Likert type scale\(^{29}\) and modified bleeding index\(^{23}\) by Mombelli et al. which led to heterogeneity in the data and exclusion from meta-analysis.

All the studies had a follow-up time of a year\(^{2,8,9,29}\) apart from the study of Sargolzaie et al.\(^{28}\) whose follow-up time was just 1 month.

Scientifically, literature reports that full mobilization of interdental papilla has always resulted in damage to papilla height and consequent necrosis of tissues that are not adequately detached,\(^{8,27}\) whereas it does not affect the probing depth and clinical attachment.\(^{30}\) The results of our systematic review and meta-analysis are largely influenced by the data contributed by von Arx et al.\(^ {2}\) They have contributed substantial weight in this review as their contribution was 47\%, 48\%, 95\%, and 97\% for gingival recession, papilla height, clinical attachment loss, and probing depth, respectively. The results may have changed with the addition of few more studies, however, there were no more clinical trials to the best of our knowledge.

After systematic literature search, it can be concluded that this is the first systematic review on effects of incision technique on the periodontal parameters in periradicular surgery. To make the results more generalizable, the most common incision techniques were taken into consideration. Risk of bias of the individual studies and of the overall systematic review was

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[Figures 1, 2, 3, 4: Forest plots showing mean difference for effect of flap design on gingival recession, papilla height, clinical attachment loss, and probing depth, respectively.](#)

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**Figure 1:** Literature search Preferred Reporting Items for Systematic Reviews and Meta-Analysis flowchart. \(n\) – No of studies, RCT – Randomized controlled trial

**Figure 2:** Forest plot presenting mean difference for effect of flap design on gingival recession. SD – Standard deviation, CI – Confidence Interval, df – Degree of freedom, \(P\) – Level of significance, \(I^2\) – Heterogeneity, \(Z\) – Effect size

**Figure 3:** Forest plot presenting mean difference for effect of flap design on loss of papilla height. SD – Standard deviation, CI – Confidence interval, df – Degree of freedom, \(P\) – Level of significance, \(I^2\) – Heterogeneity, \(Z\) – Effect size

**Figure 4:** Forest plot presenting mean difference for effect of flap design on probing depth. SD – Standard deviation, CI – Confidence interval, df – Degree of freedom, \(P\) – Level of significance, \(I^2\) – Heterogeneity, \(Z\) – Effect size
assessed. The limitations are that blinding of the participants was not possible due to surgical nature of the procedure and no concrete conclusions could be drawn on account of limited data and follow-up periods. We endorse conducting more randomized controlled trials with larger sample size having vigilant inclusion and exclusion criteria to enhance its quality and outcomes.

CONCLUSIONS

Within the limitations of the primary studies, we infer that papilla-sparing incision technique is better than the full sulcular incision for probing depth and clinical attachment loss. The gingival recession and papilla height do not appear to get affected by either incision design. However, more clinical trials with long-term follow-ups are needed. These results may change if more clinical trials will be included in the future.

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Conflicts of interest
There are no conflicts of interest.

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