Endodontic Microsurgery

Subjects: Dentistry, Oral Surgery & Medicine
Contributor: João Miguel Marques dos Santos

Endodontic microsurgery (EMS) aims to eradicate the sources of infection once the apical root resection removes most of the infected anatomical structures and repairs potential procedural errors in the apical region. This surgical procedure is characterized by the use of an operating microscope which improves illumination and magnification, thus allowing to meticulously identify apical anatomy and examine the resected root surface. EMS also demands the use of ultrasonic devices to perform root-end preparation. An additional feature of microsurgery is the absence or minimal bevel of the root respected surface, to decrease the amount of dentinal tubules exposed to microbial leakage.

Keywords: apicoectomy ; endodontic microsurgery ; endodontic-periodontal lesion ; isolated endodontic lesion ; outcome ; prognostic factors

1. Introduction

Periodontitis is defined as a chronic multifactorial inflammatory disease triggered by dysbiotic subgenvival biofilm that gradually promote the destruction of the tooth's supporting structures, including alveolar bone and periodontal ligament. Periodontal attachment loss is diagnosed by clinical attachment loss, periodontal pocket depth, bleeding on probing, and radiographic alveolar bone loss [1]. Severe periodontitis is the sixth most prevalent disease worldwide, with a prevalence of 11.2% and over 743 million affected people, significantly impairing quality of life as it may lead to tooth loss and considerable masticatory function compromise [1][2][3]. Moreover, systemic health repercussions may occur. Furthermore, the current population aging is expected to become associated with an increase in the prevalence of periodontal attachment loss [2][3].

An endodontic-periodontal lesion yields a pathological communication between both pulp and periodontal tissue through the apex, lateral canals, and/or dentinal tubules [1][4][5]. Regarding EMS in such clinical diagnosis, two scenarios may occur: the tooth subjected to the procedure may be posteriorly affected by periodontal attachment loss, or a tooth exhibiting periodontal disease can undergo EMS [6]. In either scenario, EMS decreases root length, thus altering the crown-to-root ratio (CRR) and periodontal support. Also, this procedure modifies the tooth's biomechanical response, causing unfavorable stress distribution and increased tooth mobility, which may influence tooth function and survival as it remains exposed to continuous occlusal loading [7][8]. Periodontal bone loss also aggravates CRR, simultaneously increasing the clinical crown length and decreasing the supported root area. Since the functional stress is mostly concentrated on the cervical root third, periodontal bone loss has a greater influence on biomechanical parameters than the apical root resection itself [7][6][8]. Moreover, as mentioned above, patients' occlusion also impairs tooth stability after EMS. [7].

2. Impact of Periodontal Attachment Loss on the Outcome of Endodontic Microsurgery

EMS aims to eliminate the entire necrotic tissue from the surgical site and provide an adequate apical sealing, consequently allowing hard and soft tissues' integrity restauration and reestablishment of the dentogingival complex [9].

Regarding the follow-up period, surgical retreatment cases are prone to heal faster than nonsurgical ones [10]. Song et al. [11] demonstrated that the most relevant evidence concerning the healing process was obtained at the first-year post-surgery and that the variation in the clinical outcome between one and four or more years follow-up period was not significant. Hence, the one-year follow-up may be sufficient to predict long-term outcome of EMS [12]. Therefore, the present systematic review established a minimum follow-up period of one year for study inclusion, resulting in studies ranging from 1 to 10 years follow-up period of evaluation.

The effect of the root-end filling material is one of the intraoperative key factors of EMS outcome. EMS requires biocompatible materials such as IRM, Retroplast, SuperEBA, MTA, among others [13]. MTA is the preferred EMS root-end filling material in most of the studies included in this systematic review [14][15][9][13][16][17]. MTA has the ability to stimulate bone, dentin, and cementum formation, promoting tissue regeneration (e.g., periodontal ligament and cementum) [9]. Von Arx et al. [17] also suggested that the most effective seal over a follow-up period of five years was achieved with MTA. However, Zhou et al. [12] found no significant difference in EMS clinical outcomes when comparing MTA and BP-RRM, with both showing favorable biocompatibility, no cytotoxic effects and similar sealing performance. However, one study [18] found no significant influence in the success rate regarding the root-end filling material. The remaining three studies [19][20][21] did not evaluate the effect of the root-end filling material on the outcome of EMS.

Periodontitis is responsible for alveolar bone and periodontal ligament loss, as well as apical migration of epithelial root adhesion, which may jeopardize the healing process after EMS. Therefore, the prognosis of periodontally involved teeth relies on both periodontal support and surgical approach [11][20][13]. Endodontic-periodontal lesions are thus one of the most challenging scenarios in SER field [6]. A tooth may have independent or communicating endodontic and periodontal lesions. Combined lesions may initially present as isolated endodontic or periodontal lesions, with subsequent involvement of one another [6].

EMS is considered a high success procedure, although it usually covers endodontic lesions without any periodontal complications [9], once endodontic-periodontal lesions are believed to have a worse prognosis when compared to isolated endodontic lesions [19][22]. However, as previously mentioned, in the regular clinical practice settings, many cases show some degree of periodontal involvement [9]. Therefore, the lesion type seems to be a significant outcome predictor [18][13][23]. Lui et al. [14] concluded EMS prognosis may not be influenced by the presence of buccal alveolar bone dehiscence. In accordance, von Arx et al. [24] analyzed the effect of bone defects size on EMS healing outcome, reporting that marginal bone loss was not significantly associated with healing at one year reassessment. Conversely, Song et al. [21] findings identify buccal bone plate height as the only factor among periapical defects that actually influenced the healing outcome, therefore concluding that the marginal bone deficiency resulted in a greater impairment of EMS outcome than periapical bone deficiency [21].

Concerning tooth type, the impact of periodontal attachment loss in EMS prognosis is believed to differ between single and multi-rooted teeth. As aforementioned, periodontal bone loss aggravates CRR, with the decrease of the supported root length being accompanied by the increase of the clinical crown length [7][6][8]. In a single-rooted tooth, periodontal bone loss has a greater influence on biomechanical parameters than the apical root resection itself. Stress resulting from occlusal loading is mostly concentrated at the cervical third of the root rather than at the apical region [7][6][8]. In a multi-rooted tooth, the bone loss at the apical level will not affect the prognosis as unfavorably as if it occurred at the cervical level, once the volume at the cervical level that the tooth occupies is more significant than at the apical portion. However, none of the studies included in this systematic review specified the distribution of tooth type within the group with periodontal involvement. For this reason, it is not possible to draw conclusions about the possible influence of single versus multi-rooted teeth yielding periodontal attachment loss on EMS prognosis.

The patient's occlusion also has a great impact on tooth stability after EMS. In all occlusal relationships, the stress and tooth displacement maximum values at the cervix, root apex, alveolar bone, and periodontal ligament increased as the resection length increased [7]. Thus, EMS prognosis may differ among different occlusal relationships. Ran et al. showed greater stress and tooth displacement maximum values with increased overjet, followed by normal occlusions and increased overjet with deep overbites. Deep overbites had the lowest values [7].

A poor prognosis may result from the formation of a long junctional epithelium over the dehisced root surface since alveolar bone loss promotes the apical migration of gingival epithelial cells. The long junctional epithelium serves as a pathway for microorganisms dissemination, preventing the healing process which may lead to EMS failure [25][18][20][21]. To mitigate such negative outcome, some studies perform regeneration techniques such as guided tissue regeneration, aiming to potentiate EMS prognosis in endodontic-periodontal lesions [25][12][19][9]. Six studies [12][11][14][9][20][16] resorted regeneration techniques in this type of lesions. The most frequently applied materials were collagen resorbable membranes (e.g., CollaTape® and BioMend®) and/or bone substitutes (e.g., BioOss®). Kim et al. [9] associated calcium sulfate to CollaTape®. The former material is extremely biocompatible, simple and effective [9]. Several studies hypothesized that combining guided tissue regeneration with EMS may not be mandatory in teeth with intact alveolar bone [14]. However, it is expected to improve the healing outcome in teeth presenting "through and through" lesions [14] or complete buccal bone dehiscence (class F lesions according to Kim and Kratchman's classification), as confirmed by Zhou et al. [12] and Song et al. [11].

Assessment of EMS success relies on both radiographic resolution of the periapical radiolucency and absence of clinical symptoms [26]. The studies included in this systematic review follow the criteria established by Rud et al. [27] and Molven et al. [28] for healing classification. In the present review, outcome was dichotomized into success, when complete and incomplete healing was attributed, and failure, when healing was uncertain or unsatisfactory. In Kim et al. study [9], endodontic-periodontal lesions (classes D, E, and F according to Kim and Kratchman's classification) showed success rates of 77.5%, whereas classes A, B, and C evinced a 95.2% success rate, in two to five years follow-up. The high success rate regardless of the lesion type may be related to EMS advantages and/or the use of regeneration techniques [9]. However, the lower success rate of endodontic-periodontal than isolated endodontic lesions could lead to the assumption that endodontic-periodontal lesions show more failed cases over time. Notwithstanding, Song et al. [11] verified that, among the seven failure cases with long-term follow-up, only one had periodontal involvement. This study was one of the two included studies which presented a higher success rate for endodontic-periodontal lesions over the isolated endodontic ones. In a different study, Song et al. [21] excluded a subgroup of 27 teeth with complete loss of the buccal bone plate (with marginal bone loss >3 mm) while evaluating the impact of marginal bone loss on the outcome. As a result, the success rate of teeth with marginal bone loss greater than 3 mm was overestimated. If the referred subgroup, with eight reported failures, was added to the 33 cases of marginal bone loss greater than 3 mm, the success rate would decrease from 87.9% to 80%. As for the studies of Huang et al. [16] and Yoo et al. [20], the low success rates of 50% and 33.3%, respectively, can be explained by the reduced sample size (four roots and nine teeth, respectively). The validity of the reported lower success rate is weakened by a low recall rate, as well as a considerable risk of bias.

Concerning the study of von Arx et al. [15], in which a higher success rate was reported for the periodontally involved teeth, it is worth mentioning that this is a preceding study to the one published in 2021 by the same group [17], which reported a lower success rate for the endodontic-periodontal group. We hypothesize that opposing conclusions derive from the difference in the follow-up period (1 vs. 5 year). Also, we believe a longer follow-up time [17] to provide more relevant data than the one-year control [15]. This evidence highlights the importance of a sufficiently long follow-up period to detect the outcome of interest, and echoes that healing peaks in the first year after EMS, and a reversal to disease occurs in 5% to 25% of the apparently healed cases within four years after treatment [29].

In regard to the limitations of this systematic review, the first aspect to point out is the lack of geographical variability of the studies. The included 13 studies correspond to only 6 different research teams: one from Switzerland [15][17] and the remaining from Asian countries (Singapore [14][16], Korea [11][19][18][9][20][13][21][23] and China [12]). Therefore, the obtained results should be carefully evaluated as they may not reflect the worldwide effectiveness of the intervention under study. Secondly, the majority of studies have brought together cases from the Department of Conservative Dentistry of Yonsei University, in Seoul (Korea) [11][19][18][9][13][21][23]. Kim et al. study [9] presents as the starting point of all studies performed by this research team, presenting strong evidence to assume that the database may be the same for all seven studies. Thus, it is very likely that there will be a sample overlap of these studies once some are follow-ups studies. Furthermore, as mentioned above, it is possible to verify this last aspect in von Arx's studies, since the 2012 study [17] corresponds to a five-year follow up of the initial study [15]. Additionally, all studies included in the present review provide scientific evidence rendered in academical clinical settings. Aiming at reflecting the effectiveness of interventions in real-life routine conditions in general population, pragmatical clinical trials may be beneficial, with inclusion of patient reported outcomes to improve patient-clinician communication and the therapeutic decision process. Lastly, future clinical studies should be conducted to evaluate the influence of tooth type, single- or multi-rooted teeth, as well as occlusal relationships, in teeth with periodontal attachment loss on EMS prognosis.

References

1. Papapanou, P.N.; Sanz, M.; Buduneli, N.; Dietrich, T.; Feres, M.; Fine, D.H.; Flemmig, T.F.; Garcia, R.; Giannobile, W.V.; Graziani, F.; et al. Periodontitis: Consensus report of workgroup 2 of the 2017 world workshop on the classification of periodontal and peri-implant diseases and conditions. J. Clin. Periodontol. 2018, 45 (Suppl. 20), S162–S170.
2. Tonetti, M.S.; Jepsen, S.; Jin, L.; Otomo-Corgel, J. Impact of the global burden of periodontal diseases on health, nutrition and wellbeing of mankind: A call for global action. J. Clin. Periodontol. 2017, 44, 456–462.
3. European Federation of Periodontology. Dossier on Periodontal Disease 2020 (Periodontal Health for a Better Life), Madrid, Spain. Available online: https://www.efp.org/fileadmin/uploads/efp/Documents/Campaigns/Gum_health_day/Publications/EFP_Dossier_on_Periodontal_Disease_2 (accessed on 3 May 2021).
4. Herrera, D.; Retamal-Valdes, B.; Alonso, B.; Feres, M. Acute periodontal lesions (periodontal abscesses and necrotizing periodontal diseases) and endo-periodontal lesions. J. Clin. Periodontol. 2018, 45 (Suppl. 20), S78–S94.
5. Meng, H.X. Periodontic-endodontic lesions. Ann. Periodontol. 1999, 4, 84–90.
6. Jang, Y.; Hong, H.T.; Chun, H.J.; Roh, B.D. Influence of apical root resection on the biomechanical response of a single-rooted tooth—part 2: Apical root resection combined with periodontal bone loss. J. Endod. 2015, 41, 412–416.
7. Ran, S.J.; Yang, X.; Sun, Z.; Zhang, Y.; Chen, J.X.; Wang, D.M.; Liu, B. Effect of length of apical root resection on the biomechanical response of a maxillary central incisor in various occlusal relationships. Int. Endod. J. 2020, 53, 111–121.
8. Jang, Y.; Hong, H.T.; Roh, B.D.; Chun, H.J. Influence of apical root resection on the biomechanical response of a single-rooted tooth: A 3-dimensional finite element analysis. J. Endod. 2014, 40, 1489–1493.
9. Kim, E.; Song, J.S.; Jung, I.Y.; Lee, S.J.; Kim, S. Prospective clinical study evaluating endodontic microsurgery outcomes for cases with lesions of endodontic origin compared with cases with lesions of combined periodontal-endodontic origin. J. Endod. 2008, 34, 546–551.
10. Kvist, T.; Reit, C. Results of endodontic retreatment: A randomized clinical study comparing surgical and nonsurgical procedures. J. Endod. 1999, 25, 814–817.
11. Song, M.; Chung, W.; Lee, S.J.; Kim, E. Long-term outcome of the cases classified as successes based on short-term follow-up in endodontic microsurgery. J. Endod. 2012, 38, 1192–1196.

12. Zhou, W.; Zheng, Q.; Tan, X.; Song, D.; Zhang, L.; Huang, D. Comparison of mineral trioxide aggregate and iroot bp plus root repair material as root-end filling materials in endodontic microsurgery: A prospective randomized controlled study. J. Endod. 2017, 43, 1–6.
13. Song, M.; Jung, I.Y.; Lee, S.J.; Lee, C.Y.; Kim, E. Prognostic factors for clinical outcomes in endodontic microsurgery: A retrospective study. J. Endod. 2011, 37, 927–933.
14. Lui, J.; Khin, M.; Krishnaswamy, G.; Chen, N. Prognostic factors relating to the outcome of endodontic. J. Endod. 2014, 40, 1071–1076.
15. von Arx, T.; Jensen, S.S.; Hänni, S. Clinical and radiographic assessment of various predictors for healing outcome 1 year after periapical surgery. J. Endod. 2007, 33, 123–128.
16. Huang, S.; Chen, N.; Yu, V.S.H.; Lim, H.A.; Lui, J.N. Long-term success and survival of endodontic microsurgery. J. Endod. 2020, 46, 149–157.
17. von Arx, T.; Jensen, S.S.; Hänni, S.; Friedman, S. Five-year longitudinal assessment of the prognosis of apical microsurgery. J. Endod. 2012, 38, 570–579.
18. Song, M.; Kim, S.G.; Lee, S.; Kim, B.; Kim, E. Prognostic factors of clinical outcomes in endodontic microsurgery: A prospective study. J. Endod. 2013, 39, 1491–1497.
19. Song, M.; Kang, M.; Kang, D.R.; Jung, H.I.; Kim, E. Comparison of the effect of endodontic-periodontal combined lesion on the outcome of endodontic microsurgery with that of isolated endodontic lesion: Survival analysis using propensity score analysis. Clin. Oral Invest. 2018, 22, 1717–1724.
20. Yoo, Y.; Kim, D.; Perinpanayagam, H.; Baek, S.; Zhu, Q.; Safavi, K.; Kum, K. Prognostic factors of long-term outcomes in endodontic microsurgery: A retrospective cohort study over five years. J. Clin. Med. 2020, 9, 2210.
21. Song, M.; Kim, S.G.; Shin, S.J.; Kim, H.C.; Kim, E. The influence of bone tissue deficiency on the outcome of endodontic microsurgery: A prospective study. J. Endod. 2013, 39, 1341–1345.
22. Nowzari, H.; MacDonald, E.S.; Flynn, J.; London, R.M.; Morrison, J.L.; Slots, J. The dynamics of microbial colonization of barrier membranes for guided tissue regeneration. J. Periodontol. 1996, 67, 694–702.
23. Kim, D.; Lee, H.; Chung, M.; Kim, S.; Song, M.; Kim, E. Effects of fast- and slow-setting calcium silicate—based root-end filling materials on the outcome of endodontic microsurgery: A retrospective study up to 6 years. Clin. Oral Investig. 2020, 24, 247–255.
24. von Arx, T.; Hänni, S.; Jensen, S.S. Correlation of bone defect dimensions with healing outcome one year after apical surgery. J. Endod. 2007, 33, 1044–1048.
25. Kim, E.; Kim, Y. Endodontic microsurgery: Outcomes and prognostic factors. Curr. Oral Health Rep. 2019, 6, 356–366.
26. Albanyan, H.; Aksel, H.; Azim, A.A. Soft and hard tissue remodeling after endodontic microsurgery: A cohort study. J. Endod. 2020, 46, 1824–1831.
27. Rud, J.; Andreasen, J.O.; Jensen, J.E. Radiographic criteria for the assessment of healing after endodontic surgery. Int. J. Oral Surg. 1972, 1, 195–214.
28. Molven, O.; Halse, A.; Grung, B. Observer strategy and the radiographic classification of healing after endodontic surgery. Int. J. Oral Surg. 1987, 16, 432–439.
29. Friedman, S. Outcome of endodontic surgery: A meta-analysis of the literature—Part 1: Comparison of traditional root-end surgery and endodontic microsurgery. J. Endod. 2011, 37, 577–578.