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Surgical efficacy of bone grafts and GTR on endodontic microsurgery: An overview of bone regeneration technology applied in magnification

Eficácia cirúrgica do enxerto ósseo e RTG na microcirurgia endodôntica: Visão geral da tecnologia de regeneração óssea aplicada à magnificação

Eficacia quirúrgica del injerto óseo y RTG en microcirugía endodóntica: Descripción general de la tecnología de regeneración ósea aplicada a la magnificación

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Abstract
Surgical endodontic procedures have been performed for over a century with new modifications in the primary technique. When traditional endodontic therapy and retreatment fail and the periapical infection persists, surgical intervention to remove the apical biofilm is recommended with an attempt to preserve the dental element. The newest breakdowns by researchers and dental surgeons are obtaining new techniques of the Guided Tissue Regeneration associated with periradicular surgery. This article presented an integrative review of a series of reported cases and vigorous analyses, expressing the results of endodontic microsurgery and GTR association. This review study aims to present clearly and concisely, encompassing complex studies and published analyses to collect the advantages and the efficacy of the use of bone grafts inserted in periradicular microsurgery. During the execution of this research to elaborate an integrative review, the previous data selection was conducted using methodological strategies to simplify and filter the substantial content inserted inside the proscript study. 86 bibliographic articles from the following databases: PubMed, Scielo, Journal of Endodontics, Science Direct, Wiley Online Library, Google Scholar, and Virtual Health Library were analyzed. Moreover, 70,9% of the studies analyzed weren't compatible with the research purpose and 29,1% were included. The principles of bone regeneration being inserted in apical lesion recovery have shown to be promising, and future studies are being encouraged to be developed to further improve applicability in surgical endodontics.
Keywords: Apicoectomy; Endodontics; Guided tissue regeneration; Oral surgery.

Resumo

Os procedimentos endodônticos cirúrgicos são realizados há mais de um século, com novas modificações na técnica primária. Quando a terapia endodôntica tradicional e o retratamento falham, a infeção periapical persiste e a intervenção cirúrgica para remover o biofilme apical é recomendada na tentativa de preservar o elemento dentário. As descobertas recentes dos cirurgiões-dentistas e pesquisadores visão obter novas técnicas de Regeneração Tecidual Guiada (RTG) associadas à cirurgia perirradicular. Este artigo apresentou uma revisão integrativa de uma série de casos relatados e análises vigorosas, expressando os resultados da RTG associada à microcirurgia endodôntica. Este estudo de revisão tem como objetivo apresentar de forma clara e concisa, englobando estudos complexos e análises publicadas, as vantagens e a eficácia do uso de enxertos ósseos inseridos em microcirurgias perirradiculares. Durante a execução desta pesquisa para a elaboração de uma revisão integrativa, foi realizada a seleção prévia dos dados utilizando estratégias metodológicas para simplificar e filtrar o conteúdo substancial inserido no estudo proscrito. Foram selecionados 86 artigos bibliográficos das seguintes bases de dados: PubMed, Scielo, Journal of Endodontics, Science Direct, Wiley Online Library, Google Scholar e Biblioteca Virtual em Saúde. Além disso, 70,9% dos estudos analisados não eram compatíveis com o objetivo da pesquisa e 29,1% foram incluídos. Os princípios da regeneração óssea inseridos no recobrimento de lesões apicais mostraram-se promissores, e estudos futuros estão sendo incentivados a serem desenvolvidos para melhorar ainda mais a aplicabilidade na endodontia cirúrgica.
Palavras-chave: Apicectomia; Endodontia; Regeneração tecidual guiada; Cirurgia bucal.

Resumen

Los procedimientos endodónticos quirúrgicos se llevan realizando desde hace más de un siglo, con nuevas modificaciones de la técnica primaria. Cuando la terapia endodóntica tradicional y el retratamiento fracasan, la infección periapical persiste y se recomienda la intervención quirúrgica para eliminar la biopelícula apical en un intento de preservar el diente. Recientes descubrimientos de cirujanos dentales e investigadores han dado lugar a nuevas técnicas de Regeneración Tisular Guiada (RTG) asociadas a la cirugía perirradicular. Este artículo presenta una revisión integradora de una serie de informes de casos y análisis vigorosos, que expresan los resultados de la RTG asociada a la microcirugía endodóntica. Este estudio de revisión pretende presentar de forma clara y concisa, abarcando estudios complejos y análisis publicados, las ventajas y la eficacia de la utilización de injertos óseos insertados en la microcirugía perirradicular. Durante la ejecución de esta investigación para la elaboración de una revisión integradora, se llevó a cabo una selección previa de los datos utilizando estrategias metodológicas para simplificar y filtrar el contenido sustancial insertado en el estudio proscrito. Un total de 86 artículos bibliográficos fueron seleccionados de las siguientes bases de datos: PubMed, Scielo, Journal of Endodontics, Science Direct, Wiley Online Library, Google Scholar y Biblioteca Virtual de Salud. El 70,9% de los estudios analizados no eran compatibles con el objetivo de la investigación y el 29,1% fueron incluidos. Los principios de regeneración ósea insertados en el recubrimiento de lesiones apicales se han mostrado prometedores, y se está fomentando el desarrollo de futuros estudios para mejorar aún más la aplicabilidad en endodoncia quirúrgica.
Palabras clave: Apicectomía; Endodoncia; Regeneración tisular dirigida; Cirugía bucal.

1. Introduction

Surgical endodontic procedures have been performed for more than a century with new modifications in the primary technique (Kellert, Chalfin & Solomon, 1994). The treatment is normally used to manage apical periodontitis when the orthograde approach (root canal treatment or retreatment) to the apical root anatomy (and infection) is irretrievably obstructed. In addition, a surgical approach may be indicated when the periradicular tissues require direct visualization, debridement, excision, biopsy, or management due to biomechanical failures (Ng & Gulabivala, 2023).

As claimed by Mitthra et al., (2022), occasionally a well-executed endodontic treatment can fail due to microbial infection that is not eradicated throughout the endodontic therapy, which focuses on meticulous cleaning, shaping, and disinfection of the root canal system and/or periradicular area. A draining fistula, pain on mastication, and the unintentional discovery of a radiolucent periapical lesion increasing in size are all elements suggesting the failure of the initial endodontic treatment, expressing that the persistent microbes need to be removed to enable the integrity of the teeth and structures around it. When traditional endodontic therapy and retreatment fail and the periapical infection persists, surgical intervention to remove the apical biofilm is recommended with an attempt to preserve the dental element. The retrograde apical sealing with

sealing material, such as mineral trioxide aggregate (MTA), respectively, is one of the common protocols applied at the periradicular procedure treated surgically (Martins et al., 2023).

According to Kellert et al. (1994), the bone related to the evolved periapical lesion can be injured, leading to bone loss and suggesting dual causes or secondary periodontal involvement. Even in purely endodontic cases, epithelial proliferation could result in a long junctional epithelial attachment. In either case, successful treatment may depend more on the control of epithelial proliferation than root end management. Given the high and predictable periapical healing rates (over 80%) following root canal treatment or root canal retreatment, the number of cases demanding surgical endodontics should constitute a relatively small proportion of those with periapical disorder requiring control. Similarly, the spreading insight about the efficacy of root canal retreatment should lead to a relative decline in the necessity for surgical endodontic treatment and the approach prognosis typically depends on the size and position of the bone defect (Ng & Gulabivala, 2023; Mitthra et al., 2022).

The principles of Guided Tissue Regeneration (GTR) have been applied in implantology to regenerate bone defects and enhance alveolar ridge augmentation with local application of growth factors and modulation agents have been used to maximize tissue response (Martins et al., 2023). The newest breakdowns by dental surgeons are obtaining new techniques and perspectives of the GTR associated with periradicular surgery. The studies are attempting to increase and encourage new research and investigations concerning this subject. As a result, many cases reported have shown how the patients have responded physiologically to this technique and if the possibility of bone formation after periapical surgery by inserting a bone transplant into the bony defect is positive. This article presented an integrative review of a series of reported cases and profound analyses published, expressing the scientific results of endodontic microsurgery and GTR association.

Conclusively, this review study aims to present clearly and concisely, encompassing complex studies and published analyses to collect the advantages and the efficacy of the use of bone grafts inserted in periradicular microsurgery. The discussion is based on the results explained with the article reports and evidence of how the technique can also help the satisfactory prognosis and how this technology can be applied in the actual generation of endodontic surgical treatment.

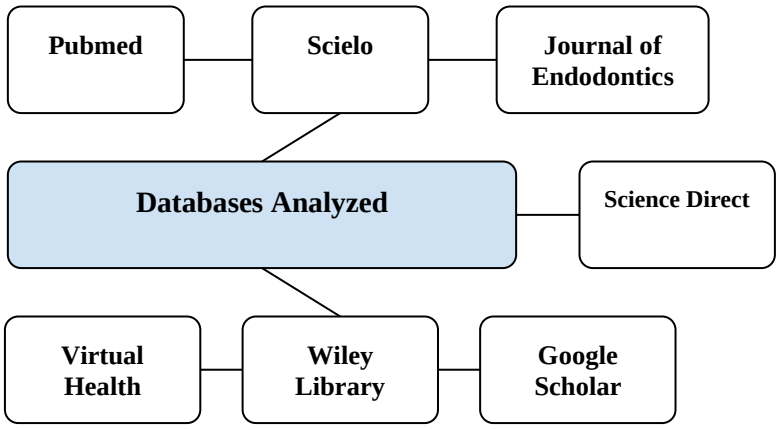
2. Methodology

Snyder (2019) explains that building your research on and relating it to existing knowledge is the structure block of all academic research activities, regardless of discipline. A literature review can considerably be defined as a systematic method of collecting and synthesizing previous research. An effective and well-conducted review as a research strategy creates a strong foundation for advancing learning and promoting theory development. By integrating findings and perspectives from many empirical findings, a literature review can address research questions with a power that no single study has (Snyder, 2019). The intent of using an integrative review method is to overview the facts base, to critically review and potentially reconceptualize, and to expand on the theoretical foundation of the precise topic as it evolves (Snyder, 2019). This type of review often requires a more creative collection of data, as the objective is usually not to cover all articles ever published on the subject but rather to combine perspectives and insights from different fields or research traditions (Snyder, 2019).

During the execution of this research to elaborate an integrative review, the previous data selection was conducted using methodological strategies to simplify and filter the substantial content inserted inside the proscript study. To maintain an integrative and qualitative literature/bibliographic review, 86 bibliographic articles published in English from the following databases (Figure 1): PubMed, Scielo, Journal of Endodontics, Science Direct, Wiley Online Library, Google Scholar, and Virtual Health Library were analyzed previously and filtered (Figure 2) to compose the final review. In terms that concern periodicity, it was substantial to explore more recent research, despite a few studies/articles that bring aged theories and

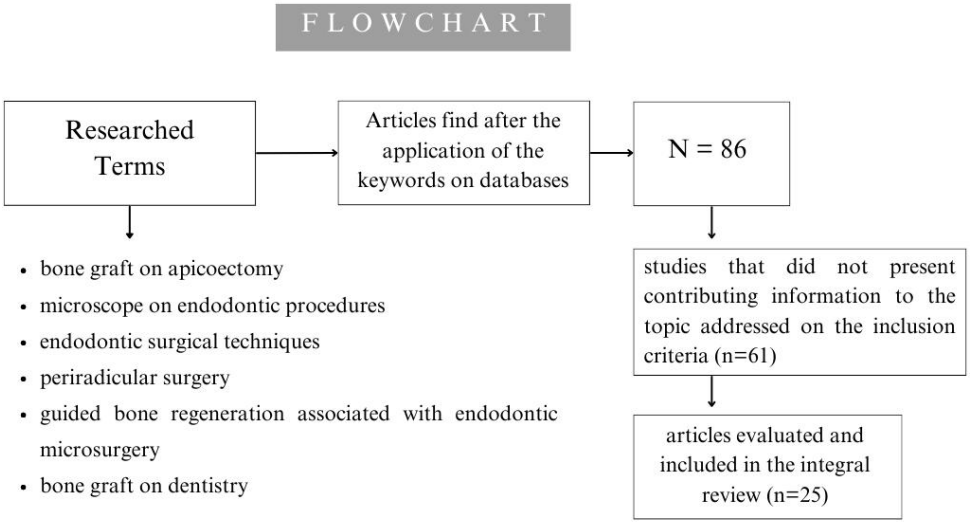
concepts about the theme that were also included in the discussion. Otherwise, to englobe a recent perspective, Table 1 with the primordial references responsible for building an overview and discussion in general, which is presented by this integrative review was only filled with studies published between 2011 and 2023.

Figure 1 – Fluxogram representing the databases analyzed and periodicals inserted into the research methodological aspects.



Source: Authors (2024).

Figure 2 – Flowchart representing the decrease in the number of articles during the filtering and data collection process.



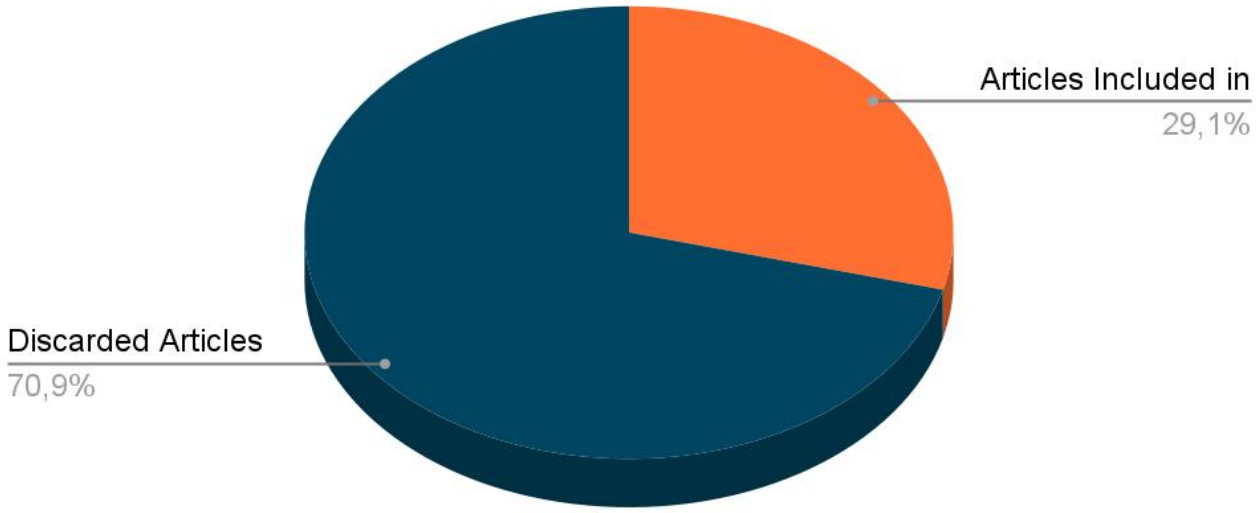
Source: Authors (2024).

2.1 Inclusion and Exclusion Criteria

In addition, as an inclusion criterion, materials consistent with the researched terms were evaluated and included in the integral review (n=25), which are: bone graft on apicoectomy, microscope on endodontic procedures, endodontic surgical techniques, periradicular surgery, guided bone regeneration associated with endodontic microsurgery and types of bone graft on dentistry. Cases reported and case studies were also included, with the view objective of understanding the management of the technique and how the news approach has been developed by global professionals who work with the technique.

The studies that did not correspond or were capable of being included with the predefined objective in methodological development or did not present contributing information to the topic addressed on the inclusion criteria (n=61), were not applied in the proscript integrative final review. Moreover, 70,9% of the studies analyzed previously weren't compatible with the research objective and 29,1% were included and entirely reviewed in reason to compose the research proposal. Behind the dynamic of exclusion and inclusion criteria aspects, the percentual regarding the studies in and out of the review was expressed, included, and applied in Chart 1, respectively:

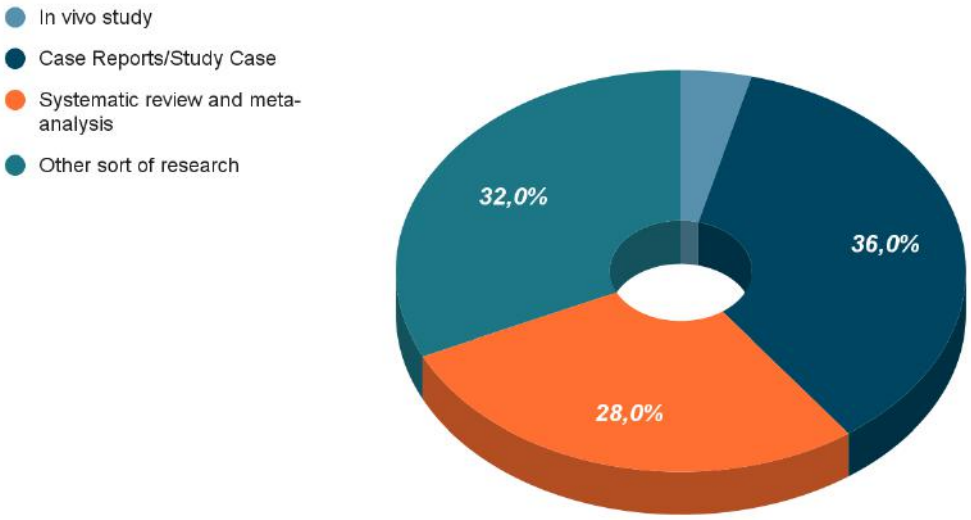
Chart 1 – Percentage graphic exposing the studies included and excluded in the integrative review.



Source: Authors (2024).

The studies that correspond adequately with the predefined intent in methodological outcome information to the subject discoursed on the inclusion criteria were specified in Chart 2, which demonstrates the classification of the studies, specific research, cases reported, analyses, and articles inserted in the entire final integrative review, respectively:

Chart 2 – Percentage graphical expressing the studies and analyses included with their respective classifications.



Source: Authors (2024).

3. Results and Discussion

Although Guided Tissue Regeneration (GTR) has been used successfully in periodontal procedures for years, it has had limited acceptance in surgical endodontic treatment. This treatment modality is not usually considered to be the first line of periapical disease management, there are treatment protocols that are daily prioritized, which usually follow (primary) root canal treatment or (secondary) root canal retreatment, and when the pathology is not solved, the periapical surgical approach can be considered (Siqueira & Rôças 2022; Fransson & Dawson 2023; Ng & Gulabivala 2023).

Treatment modalities following the failure of endodontic conventional treatment are root canal retreatment (ReRCT), apicoectomy, or extraction. In reports described by Alajmi et al. (2022) the apicoectomy success after 1–10 years rates ranges from 59.1% to 93%. In retreatment after 2– 10 years, the success rate ranges from 42.1 to 86%, with higher success rates attributed to techniques and materials. By removing the diseased tissue, debriding the canal system, and sealing the defect or cavity, the surgeon prevents or reduces the spread of microorganisms within the periradicular tissues. Regeneration of periapical defects may be a significant concern in periradicular surgery. In such possibilities, the gingival connective tissue can proliferate, or the oral epithelium can resettle into the defect, preventing the development of normal trabecular bone.

The specialists affirm that the surgical approach is not the first option since endodontics professionals have the primary objective of preserving and conserving structures, surgical intervention tends to be less frequent, however, in situations where there is a need for a surgical approach, studies explore the effectiveness, possibilities, and viability of bone grafts in connection with the common technique of periapical surgery. According to Taschieri et al., (2007a, 2011b) the association of endodontic surgery and guided tissue regeneration for the treatment of through-and-through periapical lesions leads to excellent outcomes for up to 4 years.

The latest year's studies already affirmed that GTR techniques may even improve the outcome of bone regeneration after surgical endodontic treatments of teeth with certain lesions and other old case reports suggest that the use of periosteal grafts in surgical therapy of combined periapical–periodontal lesions may contribute to a successful clinical outcome, as well

(Tobón-Arroyave et al., 2004; Tsesis et al., 2011; Bernabé et al., 2013). The recent articles and research still induce the applicability of the bone graft and also stimulate new outcomes with new overviews to understand even more how the bone regeneration technology can benefit endodontic microsurgery, the review applied in Table 1 shows a perspective of studies between 2011 and 2023.

Hard tissue can be restored using guided tissue regeneration (GTR) in junction with endodontic treatment for endodontic-periodontal lesions, affirm Alajmi et al. (2022). Using GTR in endodontic surgery on lesions that involve both the buccal and palatal alveolar cortical plates is recommended. Sumangali et al., (2021) explain that regeneration is the best method as it will restore the function of the periapical tissue to the previous tissue, furthermore and with review association, Taschieri et al., (2007) also demonstrated the success of the technique associated with microsurgical endodontic instruments, confirming the viability of increasing the procedure with the microscope use and application. (Topic 3.4).

3.1 Outcomes of the bone graft on periradicular surgery

Several authors with the aid of published report cases continuously affirm that the technique, even with some capacity of becoming better, can develop a great prognosis for bone reconstruction. Surgical endodontic treatments aim to regenerate periradicular tissues, including cementum, periodontal ligament, and alveolar bone, aligning with the goals of GTR, which plays a significant role in the procedures when space preservation is needed (Martins et al., 2023). Liu et al. (2021) explain that new treatment modalities are needed to optimize the healing outcome of endodontic surgery. Regenerative techniques, especially barrier membranes, bone grafting, and autologous platelet concentrates (APCs), are widely applied to promote tissue and bone regeneration in periodontal or implant surgery. Based on their favorable efficacy in periodontology and implant dentistry, there is substantial interest in using regenerative techniques as an adjunct to endodontic surgery to modulate the microenvironment in favor of tissue and bone reconstruction in periapical defects. Various materials are used for regenerative techniques in endodontic surgery. Liu et al. (2021) affirm that the most commonly used materials able to prevent the apical migration of epithelial cells and facilitate repopulation of the bony defect by osteogenic cells are: barrier membranes, non-resorbable expanded polytetrafluoroethylene (e-PTFE) and bioabsorbable collagen.

Table 1 demonstrates an overview of the outcome of studies between 2011 and 2023. The studies inserted on the overview table are systematic reviews, meta-analysis studies, case reports, reports with follow-up cases, and one in vivo study with the perspective of the researchers on the application of bone graft in periradicular surgery, as the conclusion aspects of it, are individually explained by:

Table 1 - Outcomes of the bone graft on the endodontic microsurgery according to systematic reviews, meta-analysis studies, case reports, reports with follow-up cases, and one in vivo study published between 2011 and 2023.

Author And Year	Study Headline/Title	Conclusion
Bernabé, P. F. E., Gomes-Filho, J. E., Dezan-Júnior, E., Prieto, A. K. C., Samuel, R. O., & Cintra, L. T. A. (2013)	Combined therapy with mineral trioxide aggregate, and guided tissue regeneration for a large radicular cyst: a 13-year follow-up.	The combination of apical surgery and regenerative techniques can successfully help the treatment of periapical lesions of endodontic origin and is suitable for the management of challenging cases.
Mitthra, S., Shobhana, R., Gayathri, K., Prakash, V., Janani, B., & Subbiya, A. (2022)	Surgical management of periapical lesion using bone graft: two case reports.	Endodontic therapy in combination with periapical surgery has a very good prognosis with the appropriate use of bone formation-promoting materials.
Artzi, Z., Wasersprung, N., Weinreb, M., Steigmann, M., Prasad, H. S., & Tsesis, I. (2012)	Effect of guided tissue regeneration on newly formed bone and cementum in periapical tissue healing after endodontic surgery: an in vivo study in the cat	Significantly bone formation after surgical treatment when membrane and bone grafts were used as compared with bone grafts only or unfilled control sites. However, it appears that the key factor to enhanced tissue regeneration is the membrane and not the grafted biomaterial

Liu, T. J., Zhou, J. N., & Guo, L. H. (2021).	Impact of different regenerative techniques and materials on the healing outcome of endodontic surgery: a systematic review and meta-analysis	Regenerative techniques improve periapical lesion healing after endodontic surgery. The combined use of collagen membranes and bovine-derived hydroxyapatite may be beneficial as an adjunct to endodontic surgery. In contrast, the positive efficacy of e-PTFE membranes or APCs alone remains doubtful.
Sumangali, A., Tiwari, R. V., Kollipara, J., Mirza, M. B., Brar, R. S., & Dhewale, A. M. (2021)	Various assisted bone regeneration in apicectomy defects systematic review and meta-analysis.	Regenerative procedures are beneficial in apicectomy. The materials used in these procedures will augment the outcome. A better prognosis is expected if the combination of the materials is used.
Taschieri, S., Corbella, S., Tsesis, I., Bortolin, M., & Del Fabbro, M. (2011).	Effect of guided tissue regeneration on the outcome of surgical endodontic treatment of through-and-through lesions: a retrospective study at 4-year follow-up.	The association of endodontic surgery and guided tissue regeneration for the treatment of periapical lesions leads to excellent outcomes up to 4 years.
Tsesis, I., Rosen, E., Tamse, A., Taschieri, S., & Del Fabbro, M. (2011)	Effect of guided tissue regeneration on the outcome of surgical endodontic treatment: a systematic review and meta-analysis	GTR techniques improve the outcome of bone regeneration after surgical endodontic treatments of teeth with certain lesions.
Alajmi, B., Karobari, M. I., & Aldowah, O. (2022).	Treatment of a large through and through periapical lesion using guided tissue regeneration: A case report of 2 years follow-up.	The use of the bioactive membrane in endodontic surgery should be considered to best restore the attachment apparatus to the tooth and prevent the down growth of a long junctional epithelium, which results in scar tissue healing.
Sumangali, A., Naik, A. C., Mohan, N., Gautam, N., Abrol, S., Mustafa, M., & Tiwari, H. (2021).	Bone regenerative biomaterials in periapical surgery: A systemic review and meta-analysis.	Regenerative materials can be used for the successful outcome of periapical surgeries. The guided tissue regeneration along with the bone regenerative materials may aid in the good prognosis of endodontic and periodontal cases.
Zubizarreta-Macho, Á., Tosin, R., Tosin, F., Velasco Bohórquez, P., San Hipólito Marín, L., Montiel-Company, J. M., ... & Hernández Montero, S. (2022).	Influence of Guided Tissue Regeneration Techniques on the Success Rate of Healing of Surgical Endodontic Treatment: A Systematic Review and Network Meta-Analysis	GTR techniques increased the success rate of endodontic surgery. The use of bone grafts plus membranes as an adjunct to surgical endodontic treatment promoted periapical bone healing, with a higher success rate, and improved the prognosis. The study recommends the use of bone grafts plus membranes as a GTR
Martins, J. N., Pires, M. D., Beatriz Pereira, D. D. S., Cruz, P. M., & António Ginjeira, M. D. (2023).	Management of apico-marginal defects with endodontic microsurgery and guided tissue regeneration: a report of thirteen cases.	Endodontic microsurgery with guided tissue regeneration is a viable treatment option in managing teeth with large periapical lesions and apico-marginal defects.
E, D., Kumar, A., Tewari, R. K., Mishra, S. K., & Iftekhar, H. (2015).	Management of large periapical lesion with the combination of second-generation platelet extract and hydroxyapatite bone graft: a report of three cases.	The use of PRF and HA bone graft might accelerate bone regeneration.

Source: Authors (2024).

3.2 Different types of grafts used in association

Rankow e Krasner (1996) explain that there are several possible causes of failure following nonsurgical and surgical endodontic treatments and many of the causes of these failures can be attributed to the presence of endodontic-periodontic bone loss around roots, exploring the possibilities of this bone regeneration and providing a positive prognosis to patients. The development of guided-tissue regeneration (GTR) procedures in periodontal therapy has led to the successful treatment of some types of periodontal bone loss, and the application of GTR on periapical treatment may maintain new bone formation, provide vital osteogenic cells (osteogenic effect), induce host cells to reconstruct lost bone (osteoinductive effect) and act as scaffolds on which host osteogenic cells might grow (osteoconductive effect) (Liu, Zhou & Guo, 2021). Bone grafts and their substitutes are often necessary to provide support, fill voids and enhance biological repair of skeletal defects. Bone substitutes can be categorized into bone grafts (autograft, allograft, xenograft), ceramics/synthetics (hydroxyapatite, tricalcium phosphate,

calcium sulfate) and growth factors (human demineralized bone matrix, platelet derivatives, bone morphogenic proteins (Cheah et al., 2021).

When it comes to biomaterial association applied to the technique, some studies expressed the possibility of associating different graft types at the same time, and concerning the collagen membrane, the observations of Sumangali et al., (2021) describe that the combination of collagen with the bovine material had better results than when used alone. This material is easily accepted, does not elicit any host response, and the collagen membrane was better evaluated when associated with bovine-derived hydroxyapatite in combination. Deenadayalan et al., (2015) express that PRF with hydroxyapatite bone graft might accelerate bone regeneration. However, histological studies are more appropriate to understand better the bone regeneration process. Bone Grafts such as Bio-GideTM and Bio-OssTM have osteoconductivity and can act as a framework to permit the inflow of host osteogenic cells and it is biocompatible.

Researchers' results suggest that GTR techniques using membranes do not contribute to increased periapical bone regeneration regardless of the membrane type. Studies developed in 2011 found no statistically significant differences among the membrane alone, platelet-rich plasma alone, and the two combined, but in 2022 other newest studies affirmed that the materials in association can impact positively the technique (Zubizarreta-Macho et al., 2022). Martins et al., (2023) indicate that grafts derived from different sources, with ideal properties of osteoinduction, osteoconduction, and osteogenesis can be utilized and among these options, autogenous grafts (which possess all 3 desired properties) are still widely regarded as the gold standard in this context. Concentrated growth factor and bone grafts in unison can be utilized with great effect to yield resounding success in stem the repair and regenerative process (Sureshbabu, Ranganath & Jacob, 2020). Some studies were able to discuss the combination of the materials, confirming that the graft association is advocated for an improved outcome than the application of the individual material, as shown previously.

As maintained by Mitthra et al., (2022) the optimal bone graft replacement material should be physiologically inert, noncarcinogenic, and structurally stable. It also should be easily degradable, matching the rate of formation of the new bone. A study regarding tissue healing based on radiographic changes discovered that the size of the lesion and the time it took to heal had a direct relationship. As a result, clinical cases on the report of Mitthra et al., (2022) were considered a success because no discomfort was recorded at the six-month and 1-year recall visits, the soft tissues showed no changes, and the teeth were in proper function with significant bone formation in the follow-up radiographs.

Reviewing a meta-analysis developed by Liu, Zhou, & Guo (2021) to understand the regenerative techniques and materials on the healing outcome of endodontic surgery, it was possible to conclude in subgroup analysis the variability of the results, as the use of e-PTFE membranes alone barely benefited the outcome of endodontic surgery, whilst the application of collagen membranes or APCs alone might accelerate the healing process. In addition, the combined use of bioabsorbable collagen membranes and bovine-derived hydroxyapatite significantly promoted the healing of periapical wounds at one year. Within the limitations of a few studies, it was found that GTR techniques increased the success rate of endodontic surgery. The use of bone grafts plus membranes as an adjunct to surgical endodontic treatment promoted complete periapical bone healing, with a more heightened success rate, and improved the prognosis of endodontic surgery.

3.3 Endodontic Microsurgery and Guided Tissue Regeneration

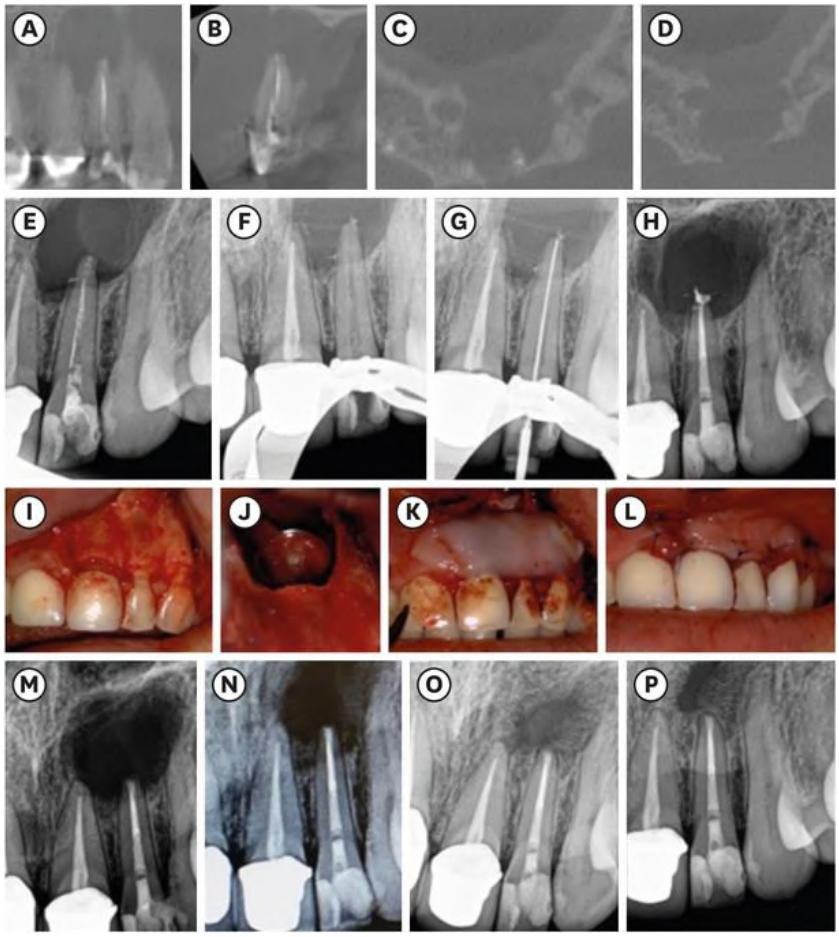
As specified by Martins et al., (2023), the past 4 decades were substantial to explore critically with scientific goals the greatest possibilities of the microscope inside the endodontic treatment. The difference between the conventional and the current Endodontic Microsurgery (EMS) techniques is very relevant and averages 65% to averages higher than 90%. Aqrabawi

et al. (2021) declare that the operating microscope was first recommended for surgical applications in endodontics and this procedure has benefited the most from a microsurgical approach. Every step of surgical endodontics benefits from enhanced magnification and illumination. Periapical curettage is facilitated since bone margins can be accurately inspected for completeness of tissue removal. Also, the apicoectomy can be carried out by using a highspeed handpiece and performed perpendicular to the long axis of the root thus ensuring the preservation of the root length. To promote a better visualization of the grafts or biomaterials, microsurgery can be a huge assistant to the operator who is executing the procedure.

Similarly, difficult cases can today be treated with a higher degree of confidence and clinical success and the microsurgical approaches offer predictable outcomes in the healing of lesions of endodontic origin. Endodontic microsurgery using MTA, ultrasonic technology, and magnification is a predictable procedure to save teeth and has demonstrated a favorable outcome (Aqrabawi et al., 2021). The shreds of evidence already discussed in association with the studies reviewed made it possible to confirm that the application of bone graft with the assistance of an operatory microscope can be more effective and this fact can impact the prognosis.

A study made in 2023 by Martins et al., (2023) exposed the analysis of thirteen cases executed and their primordial aspects, showing a conclusion that the association between endodontic microsurgery and guided tissue regeneration possesses a high efficacy and a great prognosis. EMS with guided tissue regeneration is a viable treatment option in managing teeth with large periapical lesions and apico-marginal defects, being able to evolve the bone around the apical region. Therefore the affirmations involving the material's associations, Domingos et al., (2022) and Artzi et al., (2012) declare that is possible, positive, and evolutive to use PRF as an adjunct in endodontic microsurgery, regarding every topic applied in this overview (Figure 1).

Figure 1 – Case report exposing chronological documentation and healing process after endodontic microsurgery using PRF as an adjuvant, executed in 2022. **(A, B, C, D)** views of tomography before treatment; **(E)** initial periapical radiograph of tooth #22; **(F)** cleaned root canal after irrigation; **(G)** working length confirmation; **(H)** periapical radiograph showing the final root canal treatment; **(I)** mucoperiosteal flap; **(J)** apicoectomy, retrograde preparations, and obturation with mineral trioxide aggregate; **(K)** leukocyte platelet-rich fibrin membranes filling the bone defect; **(L)** repositioning of the surgical flap; **(M)** radiograph from a 2-month follow-up; **(N)** radiograph from a 4-month follow-up; **(O)** radiograph from a 6-month follow-up; **(P)** and radiograph from a 12-month follow-up after endodontic microsurgery.



Source: Pires et al. (2022).

The most recent development in the field of GTR investigates the use of blood-derived products, such as platelet-rich-plasma (PRP), platelet-rich-fibrin (PRF), bone morphogenic proteins, platelet-derived growth factor, parathyroid hormone, and enamel matrix proteins. All of these work in different mechanisms and are thought to stimulate the healing of both soft and hard dental tissues by imitating the tissue-repair process and physiological lesion healing. Platelet-rich-plasma and PRF seem to be investigated the most as a GTR involving blood-derived products option (Baniulyte et al., 2021). The incorporation of autologous platelet concentrates in surgical endodontic procedures holds unquestionable promise when dealing with large periapical lesions (Sureshbabu et al., 2020).

Nevertheless, several pitfalls concerning the use of first-generation platelet concentrates are one too many, such as the risk of coagulopathies, use of anticoagulants, handling properties, cost, and tedious two-step centrifugation and purification process. Other aspects expressing some limitations in a few situations presented by studies is: when it comes to GTR in

periapical surgery, the lesion size appears to significantly influence the outcome of the technique. Large lesions (>10 mm in diameter), combined periodontal-endodontic lesions, and large through-and-through lesions have shown the best clinical outcomes (Baniulyte et al., 2021). However, a high number of studies affirm that the possibilities of the healing process are easier with the GTR methods and when it comes to apical surgery this process promotes a satisfactory prognosis.

4. Final Considerations

Recent research has demonstrated that regenerative techniques toward periapical healing improve the outcome of bone lesions when compared to those without the technique. Accordingly, in general, most authors recommend using bone grafts plus membranes as a GTR technique in endodontic surgery. The principles of bone regeneration being inserted in apical lesion recovery have shown to be promising, and future studies are being encouraged to be developed to further improve applicability in surgical endodontics. Multiple studies, authors, and recent experimenters express the necessity of more intense investigations, debating how some considerations concerning the healing process can be helpful to future approaches. Concerning the future research on the subject discussed, new studies must involve more clinical trials and cases reported to understand even more how the procedure can improve the endodontic surgical approach. Furthermore, the newest authors must explain more about the histopathological aspects and laboratory analyses.

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