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ARTICLE REVIEW

Microsurgical Endodontics. State-of-the-art principles and concepts

Endodoncia microquirúrgica. Principios y conceptos de vanguardia

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ABSTRACT

Introduction: endodontics has had great advances by incorporating tools such as magnification and ultrasound in order to achieve successful conventional treatments, without leaving good clinical practices aside.
Objective: to analyze the state-of-the-art principles and concepts to guarantee the success of this dental procedure.
Methods: this systematic review at a methodological level has the PRISMA procedure, considering 20 original articles that are related to the research topic; the same that were obtained from the electronic search of the following databases: PudMed, Scopus, Web of Science and SciELO.
Development: an endodontic treatment that involves surgical access should consider an adequate management not only of soft tissues but also of hard tissues and periodontal structures in order to achieve a regeneration process, most of the time by means of a first intention healing process to recover the tissue we had before the procedure, the key to achieve this being vascularization, that is, to achieve the permeability of the vessels so that they nourish the tissues.
Conclusions: Endodontic microsurgery has achieved a marked success rate, thanks to the incorporation of the microscope in the procedure sequence, allowing conservative osteotomies to be performed.

Keywords: Apicoectomy; Microsurgery; Ultrasonics; Endodontics.

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RESUMEN

Introducción: la endodoncia ha tenido grandes avances al incorporar herramientas como la magnificación y el ultrasonido con la finalidad de lograr tratamientos convencionales exitosos, sin dejar a un lado las buenas prácticas clínicas.
Objetivo: analizar los principios y conceptos de vanguardia para garantizar el éxito de este procedimiento odontológico.
Métodos: esta revisión sistemática a nivel metodológico cuenta con el procedimiento *PRISMA*, considerando 20 artículos originales que guardan relación con el tema de investigación; los mismos que se obtuvieron de la búsqueda electrónica de las siguientes bases de datos: *PudMed, Scopus, Web of Science* y *SciELO*.
Desarrollo: un tratamiento endodóntico que conlleva un acceso quirúrgico debe considerar un adecuado manejo no solo de los tejidos blandos sino de tejidos duros y estructuras periodontales para lograr un proceso de regeneración la mayoría de ocasiones por medio de una cicatrización por primera intensión para volver a contar con el tejido que teníamos antes de realizar dicho procedimiento siendo la clave para lograr esto la vascularización es decir conseguir la permeabilidad de los vasos para que nutran a los tejidos.
Conclusiones: la microcirugía endodóntica ha logrado alcanzar una tasa de éxito marcada, gracias a la incorporación en la secuencia de su procedimiento al microscopio, permitiendo realizar osteotomías conservadoras.

Palabras clave: Apicectomía; Microcirugía; Ultrasonido; Endodoncia.

INTRODUCTION

There are cases in which endodontic treatment is not enough to comply with the endodontic triad, which is why endodontic microsurgery emerged in the 1990s to help resolve those cases with persistent chronic periapical lesions after endodontic treatments, overextension of gutta-percha with symptoms, presence of apical foreign bodies, horizontal fractures, periapical lesions with conservative or prosthodontic treatment that are difficult to remove and have a good seal, complex anatomy in the apical region that complicates conventional treatment, calcified canals with or without symptoms but with periapical shadows, combined sealing among others, in which it is necessary to incorporate a surgical procedure, that is, minimally invasive periapical surgery in order to preserve the natural tooth.[1,2,3]

To achieve success of more than 90 % in procedures involving endodontic microsurgery, the microendodontic triad must be considered, that is, magnification, improved instruments, biocompatible retrograde filling materials, without leaving aside the skill and experience of the operators, achieving a much clearer field of vision and osteotomies of no more than 5 mm so that soft tissue healing is faster and less traumatic.[4,5] In this way, scientific evidence is evaluated in order to analyze the cutting-edge principles and concepts that guarantee the success of endodontic microsurgery.

Microsurgical endodontics has been one of the best options as a complementary treatment in apical lesions in which only conventional endodontic procedures cannot be solved, for which an adequate assessment of surgical access must be carried out, relying on advanced technology to achieve an increase in the success rate.[6,7]

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Take into account the thickness of the bone, especially in lower molars, implementing the digital work flow such as the use of guided surgical templates made in CAD-CAM plus CBCT, which is considered the best option to assess the proximity to anatomical structures of great importance or the 3D softward used for planning presurgical implants through which great advantages are obtained compared to the traditional freehand technique. [8,9]

Years ago, when a surgical approach had to be included after conventional endodontic treatment, that is, traditional endodontic surgery was not achieved as it is today with endodontic microsurgery, success rates of more than 93,5 % since at that time by For example, a semilunar incision was performed which did not provide a view of adequate surgical access, causing prolonged inflammation and scarring, or an osteotomy with a rotating burr caused an extensive amount of cortical bone wear, increasing postoperative pain, delayed healing, and other complications. , such as damage to special anatomical structures as indicated by the authors used in this research work. [10,11,12]

For this reason, this article defines as its objective the analysis of the cutting-edge principles and concepts that guarantee the success of this dental procedure.

METHODS

The present systematic review using the PRISMA procedure, analyzes the information from research carried out and published during the period 2018-2023; 20 original articles were considered that are related to the topic of Endodontic Microsurgery, which were obtained from the electronic search of the following databases: PudMed, Scopus, Web of Science, SciELO; These articles were selected according to the following criteria.

Inclusion criteria

a. Articles for which the full context could be acquired.
b. The largest number of articles used were those published in the last 5 years.
c. Articles in English or Spanish.

Exclusion criteria

a. Articles for which the full text could not be accessed.
b. Articles that were of no interest or use for the topic that was going to be discussed.
c. Articles that were not within the years established as a research parameter, that is, more than 10 years of publication.

The results are presented based on the inclusion and exclusion criteria set out in the methodology, in accordance with the phases of the PRISMA procedure, which are summarized in Figure 1 and Table 1.

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Table 1. Search strategy for the articles used in the research

Revistas electrónicas	Periodo de publicación	Estrategia de búsqueda	Artículos encontrados
PubMed	2018-2023	1. Endodontic microsurgery, success rate, procedure. 2. Apical surgery, profits, case report.	107
Scopus	2018-2022	1. Apical surgery, success rate, case report. 2. Endodontic microsurgery, profits, procedure.	18
ScIELO	2018-2022	1. Endodontic microsurgery, success rate, procedure. 2. Apical surgery, benefits, case report.	7

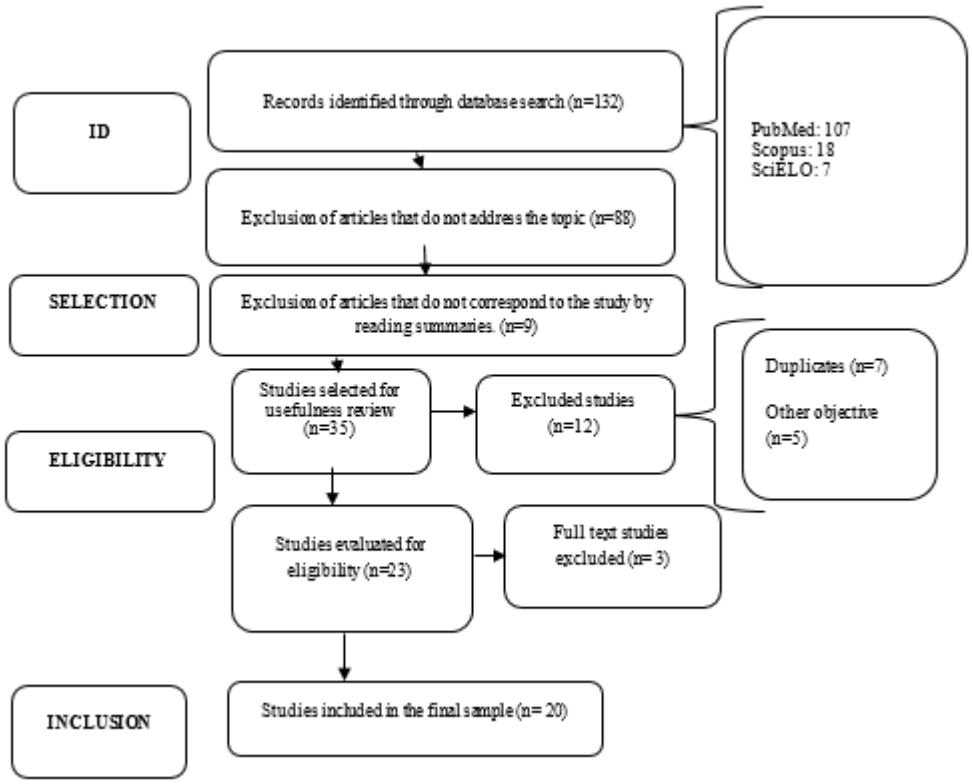

Fig. 1 Article search flow diagram.

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RESULTS

Table 2. Description of the articles used for the research.

Autor	Título	Datos	Categoría
(Leinonen & Vehkalahti, 2020)[1]	Compliance with Key Practices of Root Canal Treatment Varies by the Reward System Applied in Public Dental Services	The evaluations of clinical practices in primary non-surgical root canal treatments (RCTs) formed 2 groups according to the reward scheme: 305 RCTs (55.8%) were carried out by salaried dentists and 242 RCTs (44.2%) RCTs by dentists with a fee-for-service reward.	Root canal treatment. Non-surgical. Evaluation of root canal treatments.
(Han et al., 2022)[2]	Evaluation of a dynamic navigation system for endodontic microsurgery: study protocol for a randomized controlled trial	Endodontic microsurgery includes anesthesia, flap reflection, osteotomy, root end resection, root end preparation, root end obturation, flap repositioning, and suturing. Osteotomy with a diameter of 3-4 mm. Excessive removal of healthy bone could cause slower healing if the root apex is not accurately located.	Surgical endodontic treatment Protocols to take into consideration Guided endodontics
(Ananad et al., 2015)[3]	Endodontic microsurgery. An overview	Endodontic microsurgery includes surgical procedures that help the treatment and involves a series of procedures for the comprehensive treatment of the root canal. Eliminating disease at the root end, the need to gain a clearer understanding of the irregularity of pulp anatomy, and the use of higher magnification and illumination have given rise to apical microsurgery.	Endodontic micro triad Comprehensive treatment of root canal. Osteotomy and resection of the apical root.
(Montero et al., 2021)[4]	Biomaterials in periapical regeneration after microsurgical endodontics: A narrative review	Conventional endodontic treatment does not achieve its objectives, the periapical lesion persists (chronic persistent apical periodontitis), endodontic surgery can be supported to preserve the natural tooth. Endodontic microsurgery, compared to traditional endodontic surgery, uses advanced technology such as the use of a microscope, ultrasound tips, among others.	Bioactive endodontic cements. Endodontic surgery. Periapical repair.
(Jang M, Kim E, Min Ks Min, 2021)[5]	An Update on Endodontic Microsurgery of Mandibular Molars: A Focused Review	Endodontic treatment aims to comply with the endodontic triad, but when this is not possible, surgical endodontic treatment can be used. The first surgical treatment option when there is periradicular pathology is endodontic microsurgery.	Microsurgical endodontics. Mandibular molars.

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		Surgical endodontic treatment has evolved considerably due to new technological advances such as dental surgical microscopes, cone beam computed tomography (CBCT), computer-aided design/computer-aided manufacturing (CAD/CAM), and three-dimensional printing.	CAD/CAM technology combined with CBCT.
(Safi et al., 2019)[6]	Outcome of Endodontic Microsurgery Using Mineral Trioxide Aggregate or Root Repair Material as Root-end Filling Material: A Randomized Controlled Trial with Cone-beam Computed Tomographic Evaluation.	Apical periodontitis when persistent and recurrent can be treated predictably by modern endodontic surgery. Modern microsurgical techniques incorporate the use of an operating microscope; Ultrasonic tips for precise root tip preparation; and biocompatible root-end filling materials such as Super EBA, trioxide aggregate mineral (MTA) and, more recently, Endosequence bioceramics for better sealing and response of the apical tissue.	Cone beam computed tomography. Endodontic microsurgery. Root repair material.
(Su et al., 2021)[7]	Prognostic Predictors of Endodontic Microsurgery: Radiographic Assessment	Endodontic microsurgery (EMS) is a surgical endodontic retreatment approach characterized by modern microsurgical techniques that integrate the use of an operating microscope or endoscope, root-end cavity preparation with ultrasonic tips, and root-end filling materials. more biocompatible root, such as immediate restoration material, superethoxybenzoic acid, or mineral trioxide aggregate.	Endodontic microsurgery. Factors and prognoses. computerized cone-beam, Tomography.
(Kim et al., 2019)[8]	A new minimally invasive guided endodontic microsurgery by cone beam computed tomography and 3-dimensional printing technology	Endodontic microsurgery is defined as the treatment performed on the root apices of an infected tooth, which did not resolve with conventional root canal therapy. Advanced technology based on computed tomography has opened a new avenue in the application of precise and personalized diagnoses and has been increasingly used in the field of dentistry.	Surgical treatment: apicoectomy Cone beam computed tomography. Surgical guide.
(Prathap & Pradeep, 2021)[9]	Endodontic microsurgical instruments - a review	The indications for endodontic surgery include failed non-surgical treatment or retreatment, anatomical problems or iatrogenic errors, apical periodontitis that cannot be resolved with conventional endodontic treatment, as well as pathologies at the periapical level, among other	Surgical microinstruments. Microsurgical endodontics. Ultrasound.

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		reasons and that today Endodontic microsurgery, which goes hand in hand with technological advances such as lighting, magnification, microsurgical instruments, ultrasound and biocompatible materials, has managed to preserve natural pieces. Traditional instruments used in endodontic surgery are too large for the small osteotomy sites of microsurgery.	
(Seedat HC, Van der Vyver PJ, de Wet FA, 2018)[10]	Micro-endodontic surgery - Part 1: Surgical rationale and modern techniques.	The gap between biological concepts and the ability to achieve clinically successful results has been reduced with the use of microsurgical and ultrasonic instruments, new retrograde materials, and the use of the dental surgical microscope. The use of cone beam computed tomography for diagnosis and treatment planning describes the modern technique for endodontic microsurgery.	Dental operation microscope. CBCT: Cone beam computed tomography. Microendodontic surgery.
(Jadun et al. 2019)[11]	Endodontic microsurgery. Part two: armamentarium and technique	Modern endodontic microsurgery has a high success rate of up to 93.5%, making it a viable treatment option in the management of periapical disease when orthograde root treatment is not possible or inappropriate. Success is related to advanced techniques that have allowed professionals to overcome historical barriers.	Modern apicoectomy microsurgery. High power surgical microscope. Cone Beam Computed Tomography
(Floratos & Kim, 2017)[12]	Modern Endodontic Microsurgery Concepts: A Clinical Update	In the past, endodontic surgery was met with skepticism due to insufficient knowledge of apical anatomy, as well as the limited reported success rate offered by the older surgical technique. Microsurgical endodontic surgery uses certain technical advances, mainly the dental surgical microscope, ultrasound, modern microsurgical instruments and dental materials. Biocompatible root filling. The highest success rates were attributed to superior inspection of the surgical site and precise preparation of root tips with microinstruments using high magnification and improved illumination, achieving 96.8% and 91.5% success at follow-up. in the short term after 1 year and in the long-term follow-up after 5 to 7 years, respectively.	Surgical operating microscope. Apical surgery. Apical Microsurgery.
(Floratos et al., 2022)[13]	Bone Window Technique in Endodontic	Microsurgical endodontics has achieved very important advances.	Microinstruments

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	Microsurgery. Report of two cases	Success rates rise to 92%, proving to be a predictable treatment method thanks to the dental surgical microscope, the use of ultrasonic tips for root end preparation and more biocompatible filling materials. Proper planning is the key to microsurgery that is missing in the traditional surgical technique	Root resection, apicoectomy. Endodontic microsurgery.
(Abedi et al. 2022)[14]	Guided Endodontic Micro-Surgery (GEMS): A Novel Approach for a Targeted Apicoectomy—A Report of 3 Cases	Guided endodontic microsurgery is a surgical procedure used to treat failed endodontically treated teeth with periapical infections. Guided endodontic microsurgery can be problematic in some situations, such as when there are difficult anatomical features or limited surgical access. Some of these complex cases can be handled using cone beam computed tomography imaging, CAD software design, and 3D printing technologies.	Guided endodontic microsurgery. Targeted apicoectomy. Non-invasive procedure.
(Taschieri et al. 2021)[15]	Microsurgical endodontic treatment of the upper molar teeth and their relationship with the maxillary sinus: a retrospective multicentric clinical study	Microendodontic surgery is a surgical technique for the maintenance of devitalized teeth with apical pathology after failed endodontic therapy or when non-surgical treatment is not possible or recommended.	Microsurgical endodontics. maxillary sinus. Pain and postoperative inflammation.
(Almohaime de et al., 2022)[16]	Significance of Endodontic Case Difficulty Assessment: A Retrospective Study	The primary goal of root canal treatment is to remove irritants from the root canal, adequately fill the clean and molded system, and prevent further recontamination by sealing the root canal system.	Difficulty of the case. Setbacks in endodontics.
(Eskandar et al., 2020)[17]	Outcomes of endodontic microsurgery using different calcium silicate-based retrograde filling materials: a cohort retrospective cone-beam computed tomographic analysis	Endodontic surgery is a reliable treatment option for the preservation of teeth with post-treatment apical periodontitis after failure of non-surgical approaches. Microsurgical techniques are supported by the use of a surgical microscope, ultrasonic tips and biocompatible retrograde filling materials, based on calcium silicate. Modern techniques have significantly improved the success rate of endodontic surgery compared to traditional techniques.	Endodontic microsurgery. Added trioxide mineral. CT scan of conical beam.

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(Siragusa et al., 2021)[18]	Endodontic Microsurgery with Digital Planning and Surgical Guide	Endodontic microsurgery, an alternative surgical treatment that has incorporated cone beam computed tomography (CBCT), three-dimensional (3D) printing technology and surgical guides designed with computer-assisted software, as well as the use of a microscope, use of ultrasound, latest generation biomaterials such as MTA or bioceramics. The apical recession should be 3mm, which is more effective when performed in a guided manner than freehand surgery.	Advanced technology Digital workflow.
(Suasnabas et al., 2023)[19]	Periapical surgery: apicoectomy and cystectomy	Conventional endodontic treatments do not always resolve all periapical pathologies; many times surgical treatment must be resorted to. Apicoectomy is performed with the help of the microscope and specialized dental tools. In large bone losses, grafts or osteoinductive materials are placed.	Endodontic microsurgery Modern equipment and instruments Bone regeneration
(Joya & Fernández, 2018)[20]	Chemical-mechanical Preparation of the Apical Third in Endodontic Micro-Surgery. A Review	When conventional endodontic treatments are unsuccessful, endodontic microsurgery can be an alternative treatment. Incorporation of microscope, ultrasound tips, microinstruments, laser, and biocompatible materials allows success of more than 92% in this procedure.	Endodontic microsurgery. Advanced technology in endodontic microsurgery

Elaborated: Grijalva Palacios Miryan, 2023.

DISCUSSION

With the advent of microsurgical technology, it is possible to comply with the micro endodontic triad, which includes the use of the microscope that allows a better vision of the field, the electrical piece that provides adequate access to the surgical area, minimal loss of bone structure, protection of special anatomical entities through the use of digital guides, microsurgical instruments for all stages of the approach with an improved design to achieve the required precision, ultrasound tips that allow preparation of the root end, biocompatible materials for the apical seal, CBCT, together with the knowledge, skill and experience of the operator, achieves more effective and less invasive procedures that maintain gingival and periodontal structures aesthetically and functionally.[11, 12]

However, Han B et al.,[2] Taschieri S et al.,[12] mention that, although there is great progress in endodontic microsurgery as mentioned, the precision and efficiency of osteotomy and tooth end resection root still need to be improved to minimize surgical trauma, in general, a better prognosis has been seen in anterior teeth than in molars, this may be related to access to the surgical approach, anatomical complexity, proximity to anatomical structures such as maxillary

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sinus, mandibular canal, presence of isthmuses which must be prepared, since if it is not done the success rate ranges between 44 and 88 %.[14,18,19]

There are certain surgical considerations to take into account such as the design of the incision being of vital importance for the procedure since it provides optimal access, visibility to anatomical structures, repositioning and adequate suturing; When making the incision, the slot technique is suggested, a vertical incision with a triangular flap, a complete circular flap or a more aesthetic flap design using the Luebke-Ochsenbein submarginal flap,[17] and osteotomy with a piezoelectric saw, achieving minimal bone loss between 3 to 4 mm, bone that will serve as an autologous graft promoting complete regeneration since it is osteogenic, osteoinductive, osteoconductive and non-immunogenic. Guided tissue regeneration, that is, the use of graft, membranes or PRP, can also be considered in large endoperiodontal or periapical lesions; This does not ensure complete periapical regeneration, but it helps to improve apicomarginal bone defects caused in these cases.[18]

The 3 mm ultrasound tips allow root recession to be performed considering a therapeutic length of 6 mm that includes 3 mm of apical recession to eliminate lateral canals and apical branches and 3 mm of preparation of the root cavity in depth to clean this root cavity. area, in the preparation of the end of the root consider the presence of isthmuses which must be prepared to maximize the success of the treatment, an airtight seal of the end of the root that prevents the entry of bacteria using calcium silicate cements such as MTA or bioceramics such as Biodentine, without leaving aside suture, postoperative care and controls that together help to achieve favorable treatments.[19,20]

CONCLUSIONS

Endodontic microsurgery has managed to achieve a success rate greater than 93% thanks to incorporating in the sequence of its procedure the microscope, CBCT, microinstruments that have allowed conservative osteotomies of 3-4 mm, ultrasound tips to remove the end of the 3 mm root, biocompatible materials such as MTA or Biodentine, among other advances, achieving adequate management not only of soft tissues but also of hard tissues and periodontal structures to achieve a regeneration process, most of the time through healing by first intention to regain the tissue that we had before performing said procedure, being the key to achieving this is vascularization, that is, achieving the permeability of the vessels so that they nourish the tissues.

Conflict of interest statement
The authors declare that there are no conflicts of interest.

Author contributions
All authors participated in conceptualization, data curation, formal analysis, research, methodology, supervision, writing-original draft, writing-review and editing.

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BIBLIOGRAPHICAL REFERENCES

1. Liononen S, Vehkalahti M. Compliance with Key Practices of Root Canal Treatment Varies by the Reward System Applied in Public Dental Services. J Endodontcs[Internet]. 2021 [cited 10/06/2023]; 47(10): 1592-1597. Disponible en: https://www.sciencedirect.com/science/article/pii/S0099239921005239

2. Han B, Wang Y, Zheng C, Peng L, Sun Y, Wang Z, and Wang X. Evaluation of a dynamic navigation system for endodontic microsurgery: study protocol for a randomised controlled trial. BMJ Open[Internet]. 2022 Dec [cited 10/06/2023]; 12(12): e064901. Disponible en: https://bmjopen.bmj.com/content/bmjopen/12/12/e064901.full.pdf

3. Ananad S, Soujanya E, Raju A, Svathi A. Endodntic microsurgery. An overview. Dentistry and Medical Research[Internet]. 2015 [cited 10/06/2023]; 3(2): 31-37. Disponible en: http://dx.doi.org/10.4103/2348-1471.159172

4. Montero-Miralles P, Ibáñez-Barranco R, Cabanillas-Balsera D, Areal-Quecuty V, Sánchez-Domínguez B, Martín-González J, Segura-Egea JJ, Jiménez-Sánchez MC. Biomaterials in periapical regeneration after microsurgical endodontics: A narrative review. J Clin Exp Dent[Internet]. 2021 [cited 10/06/2023]; 13(9): e935-e940. Disponible en: http://dx.doi.org/10.4317/jced.58651

5. Jang SM, Kim E, Min KS. An Update on Endodontic Microsurgery of Mandibular Molars: A Focused Review. Medicina[Internet]. 2021 [cited 10/06/2023]; 57(3): 270. Disponible en: http://dx.doi.org/10.3390/medicina57030270

6. Safi C, Kohli MR, Kratchman SI, Setzer FC, Karabucak B. Outcome of Endodontic Microsurgery Using Mineral Trioxide Aggregate or Root Repair Material as Root-end Filling Material: A Randomized Controlled Trial with Cone-beam Computed Tomographic Evaluation. J Endod[Internet]. 2019 [cited 10/06/2023]; 45(7): 831-839. Disponible en: http://dx.doi.org/10.1016/j.joen.2019.03.014

7. Su C, Zhang R, Wang R, Yang C, Wang Z, Meng L. Prognostic Predictors of Endodontic Microsurgery: Radiographic Assessment. Int Dent J[Internet]. 2022 Oct [cited 10/06/2023]; 72(5): 628-633. Disponible en: http://dx.doi.org/10.1016/j.identj.2022.02.007

8. Kim JE, Shim JS, Shin Y. A new minimally invasive guided endodontic microsurgery by cone beam computed tomography and 3-dimensional printing technology. Restor Dent Endod[Internet]. 2019 [cited 10/06/2023]; 44(3): e29. Disponible en: http://dx.doi.org/10.5395/rde.2019.44.e29

9. Prathap MS, Pradeep R. Endodontic microsurgical instruments - a review. J Evolution Med Dent Sci[Internet]. 2021 [cited 10/06/2023] 10(20): 1532-1538. Disponible en: http://dx.doi.org/10.14260/jemds/2021/320

10. Seedat HC, van der Vyver PJ, de Wet FA. Micro-endodontic surgery - Part 1: Surgical rationale and modern techniques. S. Afr. dent. j. [Internet]. 2018 Apr [cited 10/06/2023]; 73(3): 146-153. Disponible en: https://journals.co.za/doi/abs/10.10520/EJC-f5b46eb59

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2024; 28(S1): e6510

11. Jadun S, Monaghan L, Darcey J. Endodontic microsurgery. Part two: armamentarium and technique. BDJ[Internet]. 2019 Jul [citado 17/07/2023]; 227(2): 101-111. Disponible en: https://www.nature.com/articles/s41415-019-0516-z

12. Floratos S, Kim S. Modern Endodontic Microsurgery Concepts: A Clinical Update. Dent Clin North Am[Internet]. 2017 Jan [citado 17/07/2023]; 61(1): 81-91. Disponible en: http://dx.doi.org/10.1016/j.cden.2016.08.007

13. Floratos S, Molonis V, Tsolakis A, Kykalos S, Kontzoglou K. Bone Window Technique in Endodontic Microsurgery. Report of two cases. *J Endod Microcirugía*[Internet]. 2023 [citado 17/07/2023]; 2: 24-33. Disponible en: https://doi.org/10.23999/jem.2023.2.3

14. Abedi R, Foroughi F, Zendaki M. Guided Endodontic Micro-Surgery (GEMS): A Novel Approach for a Targeted Apicoectomy—A Report of 3 Cases. Dental J Advance Studies[Internet]. 2022 [citado 17/07/2023]; 10(3): 161-169. Disponible en: http://dx.doi.org/10.1055/s-0042-1758227

15. Taschieri S, Morandi B, Giovarruscio M, *et al.* Microsurgical endodontic treatment of the upper molar teeth and their relationship with the maxillary sinus: a retrospective multicentric clinical study. *BMC Oral Health*[Internet]. 2021 [citado 17/07/2023]*;* 252(2021). Disponible en: https://bmcoralhealth.biomedcentral.com/articles/10.1186/s12903-021-01610-3

16. Almohaimede AA, AlShehri BM, Alaiban AA, AlDakhil RA. Significance of Endodontic Case Difficulty Assessment: A Retrospective Study. Int Dent J[Internet]. 2022 [citado 17/07/2023]; 72(5): 648-653. Disponible en: http://dx.doi.org/10.1016/j.identj.2022.01.001

17. Eskandar RF, Al-Habib MA, Barayan MA, Edrees HY. Outcomes of endodontic microsurgery using different calcium silicate-based retrograde filling materials: a cohort retrospective cone-beam computed tomographic analysis. BMC Oral Health[Internet]. 2023 [citado 17/07/2023]; 23(70). Disponible en: https://bmcoralhealth.biomedcentral.com/articles/10.1186/s12903-023-02782-w

18. Siragusa C, Alfie N, Giménez ML, Rodríguez PA. Microcirugía Endodóntica con Planificación Digital y Guía Quirúrgica: Caso Clínico. Rev Fac Odontol, Univ Buenos Aires [Internet]. 2021 [citado 17/07/2023]; 36(83): 13-20. Disponible en: https://revista.odontologia.uba.ar/index.php/rfouba/article/view/83

19. Suasnabas Pacheco EJ, Macías Lozano HG, Segura Cueva KA, Loayza Romero AC. Cirugía Periapical: apicectomía y quistectomía. RECIAMUC [Internet]. 2023 [citado 17/07/2023]; 7(1): 606-15. Disponible en: https://reciamuc.com/index.php/RECIAMUC/article/view/1052

20. Joya-Grajales E, Fernández-Grisales R. Preparación Químico-mecánica del Tercio Apical en Micro-Cirugía Endodóntica. Una Revisión. CES odontol. [Internet]. 2018 [citado 17/07/2023]; 31(1): 22-37. Disponible en: https://revistas.ces.edu.co/index.php/odontologia/article/view/4775