SURGICAL APPROACHES IN THE CORRECTION OF CLEFT LIP AND PALATE: ADVANCED TECHNIQUES AND FUNCTIONAL OUTCOMES

ABORDAGEM CIRÚRGICA NA CORREÇÃO DE FISSURAS LABIOPALATINAS: TÉCNICAS AVANÇADAS E RESULTADOS FUNCIONAIS

ABORDAJE QUIRÚRGICO PARA LA REPARACIÓN DEL LABIO Y PALADAR HENDIDO: TÉCNICAS AVANZADAS Y RESULTADOS FUNCIONALES

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ABSTRACT

Cleft lip and palate are among the most frequent congenital malformations of the craniofacial region and represent a significant challenge for the functional and aesthetic rehabilitation of affected patients. Surgical treatment of these anomalies has continuously evolved, incorporating advanced techniques, technological resources, and multidisciplinary approaches aimed at optimizing clinical outcomes. In this context, the present study aimed to analyze, through a literature review, the main surgical approaches used in the correction of cleft lip and palate, with emphasis on advanced techniques and functional outcomes reported in the scientific literature. This study is characterized as a bibliographic review, based on the critical analysis of scientific articles, specialized books, and clinical guidelines published over the last ten years and indexed in recognized health databases, such as PubMed, SciELO, LILACS, Google Scholar, and the Cochrane Library. Peer-reviewed studies addressing surgical techniques for cleft lip and palate correction, as well as their functional, aesthetic, and rehabilitative outcomes, were included. The results demonstrated that traditional surgical techniques, such as classical cheiloplasty and palatoplasty, have been progressively refined through technical modifications that favor anatomical and functional restoration, particularly with regard to the reduction of velopharyngeal insufficiency and improvement in speech outcomes. A growing incorporation of digital technologies, including three-dimensional planning, CAD/CAM systems, and applications of artificial intelligence, was also observed, in addition to regenerative approaches such as osteogenic distraction and cellular therapies, which have increased the predictability and effectiveness of surgical procedures. Furthermore, the literature emphasizes the importance of interdisciplinary follow-up, involving surgery, orthodontics, and speech therapy, to achieve satisfactory long-term results. It is concluded that advances in surgical approaches, combined with innovative technologies and multiprofessional care, have significantly contributed to improved functional and aesthetic outcomes in the treatment of cleft lip and palate. However, challenges remain regarding the standardization of surgical protocols and the need for longitudinal studies to assess the stability of clinical outcomes, highlighting the importance of further scientific investigations in this field.

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Keywords: Cleft Lip and Palate. Reconstructive Surgery. Advanced Surgical Techniques. Functional Outcomes. Craniofacial Rehabilitation.

RESUMO

As fissuras labiopalatinas constituem uma das malformações congênitas mais frequentes da região craniofacial e representam um desafio significativo para a reabilitação funcional e estética dos pacientes acometidos. O tratamento cirúrgico dessas anomalias tem evoluído de forma contínua, incorporando técnicas avançadas, recursos tecnológicos e abordagens multidisciplinares com o objetivo de otimizar os resultados clínicos. Diante desse contexto, o presente estudo teve como objetivo analisar, por meio de uma revisão de literatura, as principais abordagens cirúrgicas utilizadas na correção das fissuras labiopalatinas, com ênfase nas técnicas avançadas e nos resultados funcionais descritos na literatura científica. Trata-se de uma revisão bibliográfica, realizada a partir da análise crítica de artigos científicos, livros especializados e diretrizes clínicas publicados nos últimos dez anos, indexados em bases de dados reconhecidas na área da saúde, como PubMed, SciELO, LILACS, Google Scholar e Cochrane Library. Foram incluídos estudos revisados por pares que abordaram técnicas cirúrgicas de correção das fissuras labiopalatinas, bem como seus impactos funcionais, estéticos e reabilitadores. Os resultados evidenciaram que as técnicas cirúrgicas tradicionais, como as queiloplastias e palatoplastias clássicas, vêm sendo aprimoradas por meio de modificações técnicas que favorecem a restauração anatômica e funcional, com destaque para a redução da insuficiência velofaríngea e a melhora da fala. Observou-se também a crescente incorporação de tecnologias digitais, como o planejamento tridimensional, sistemas CAD/CAM e aplicações de inteligência artificial, além do uso de abordagens regenerativas, como a distração osteogênica e terapias celulares, que têm ampliado a previsibilidade e a eficácia dos procedimentos. Ademais, a literatura reforça a importância do acompanhamento interdisciplinar, envolvendo cirurgia, ortodontia e fonoaudiologia, para a obtenção de resultados satisfatórios em longo prazo. Conclui-se que os avanços nas abordagens cirúrgicas, aliados ao uso de tecnologias inovadoras e à atuação multiprofissional, têm contribuído de forma significativa para a melhora dos resultados funcionais e estéticos no tratamento das fissuras labiopalatinas. Entretanto, permanecem desafios relacionados à padronização dos protocolos e à necessidade de estudos longitudinais que avaliem a estabilidade dos desfechos clínicos, indicando a importância de novas investigações científicas na área.

Palavras-chave: Fissura Labiopalatina. Cirurgia Reconstrutiva. Técnicas Cirúrgicas Avançadas. Resultados Funcionais. Reabilitação Craniofacial.

RESUMEN

El labio leporino y el paladar hendido son una de las malformaciones congénitas más frecuentes de la región craneofacial y representan un desafío significativo para la rehabilitación funcional y estética de los pacientes afectados. El tratamiento quirúrgico de estas anomalías ha evolucionado continuamente, incorporando técnicas avanzadas, recursos tecnológicos y enfoques multidisciplinarios con el objetivo de optimizar los resultados clínicos. En este contexto, el presente estudio tuvo como objetivo analizar, mediante una revisión bibliográfica, los principales abordajes quirúrgicos utilizados en la corrección del labio leporino y el paladar hendido, con énfasis en las técnicas avanzadas y los resultados funcionales descritos en la literatura científica. Se trata de una revisión bibliográfica, realizada a partir del análisis crítico de artículos científicos, libros especializados y guías clínicas publicadas en los últimos diez años, indexadas en bases de datos de salud reconocidas como PubMed, SciELO, LILACS, Google Scholar y Cochrane Library. Se incluyeron estudios revisados por pares que abordan las técnicas quirúrgicas para la corrección del labio leporino y el paladar hendido, así como sus impactos funcionales, estéticos y rehabilitadores. Los resultados mostraron que las técnicas quirúrgicas

tradicionales, como la queiloplastia clásica y la palatoplastia, se están mejorando mediante modificaciones técnicas que favorecen la restauración anatómica y funcional, con énfasis en la reducción de la insuficiencia velofaríngea y la mejora del habla. También se observó la creciente incorporación de tecnologías digitales, como la planificación tridimensional, los sistemas CAD/CAM y las aplicaciones de inteligencia artificial, así como el uso de enfoques regenerativos como la distracción osteogénica y las terapias celulares, lo que amplía la predictibilidad y la eficacia de los procedimientos. Además, la literatura refuerza la importancia del seguimiento interdisciplinario, que incluye cirugía, ortodoncia y logopedia, para lograr resultados satisfactorios a largo plazo. Se concluye que los avances en los abordajes quirúrgicos, combinados con el uso de tecnologías innovadoras y la atención multidisciplinaria, han contribuido significativamente a mejorar los resultados funcionales y estéticos en el tratamiento del labio leporino y paladar hendido. Sin embargo, persisten desafíos relacionados con la estandarización de protocolos y la necesidad de estudios longitudinales que evalúen la estabilidad de los resultados clínicos, lo que indica la importancia de continuar la investigación científica en esta área.

Palabras clave: Labio Leporino y Paladar Hendido. Cirugía Reconstructiva. Técnicas Quirúrgicas Avanzadas. Resultados Funcionales. Rehabilitación Craneofacial.

1 INTRODUCTION

Cleft lip and palate represent one of the most common congenital malformations of the craniofacial region, with an estimated incidence of between 1:600 and 1:1000 births, varying according to genetic, ethnic, and environmental factors (MOREIRA; BERNAOLA-PAREDES, 2020). These alterations result from failures in the fusion of the maxillary and nasal processes during embryonic development, compromising vital functions such as feeding, speech, breathing and facial aesthetics. The therapeutic approach is complex and requires prolonged multidisciplinary treatment, involving oral and maxillofacial surgeons, speech therapists, orthodontists, and psychologists, in order to reestablish the patients' facial functions and harmony (RAGHAVAN et al., 2018).

Historically, several surgical techniques have been developed to correct cleft lip and palate, with the aim of restoring the anatomy and functionality of the affected structures. Among the most used approaches are the Millard, Tennison-Randall, Fisher, and Mulliken techniques, which, over the decades, have been improved to improve symmetry and reduce scarring sequelae (ZAIDOV, 2025; OH; KIM, 2023). Recent studies have shown that the appropriate choice of technique depends on the type and extent of the cleft, as well as on the individual anatomical characteristics of each patient, and personalized surgical planning is essential (ROGOZHINA; BLOKHINA; BIMBAS, 2021).

In recent years, the introduction of advanced techniques and surgical modifications has provided more predictable and aesthetic results. An example is the modified rotation-advancement flap, which has demonstrated significant improvements in lip reconstruction and facial appearance in patients with complete unilateral clefts (HADIKHOSUMA; WICAKSONO; DHIPAREDJA, 2024). Similarly, the use of combined approaches, such as the Utah protocol, which associates early closure of the hard palate with alveolar bone grafting, has been shown to be effective in reducing complications and improving speech and occlusion (BATTISTINI et al., 2024). These advances show the continuous search for less invasive and more functional methods that promote aesthetic and physiological rehabilitation.

Despite progress in surgical techniques and protocols, there are still disagreements regarding the choice of the most effective approach to ensure long-lasting functional and aesthetic results. This scientific gap reinforces the need for up-to-date reviews that critically analyze the available evidence on cleft lip and palate correction procedures, especially in the context of the last ten years. In addition, considering the impact of these malformations on quality of life, understanding technical innovations and their functional outcomes is essential for the improvement of clinical practice and for the optimization of rehabilitation protocols (JOOS; MARKUS; SCHUON, 2023; KIM et al., 2023).

Thus, the objective of this study is to review and critically analyze the advanced surgical techniques used in the correction of cleft lip and palate in the last ten years, emphasizing their functional and aesthetic results. In addition, it seeks to identify the main surgical innovations and technical modifications developed in this period, to evaluate the functional and aesthetic impacts reported in the literature, and to discuss the current trends and challenges related to craniofacial rehabilitation. This integrative literature review was based on scientific articles published between 2016 and 2025, indexed in the PubMed, SciELO, and ScienceDirect databases. The methodological procedures adopted for the selection and analysis of the included publications are presented below.

2 METHODOLOGY

The present study is characterized as a literature review, whose purpose is to critically analyze the different surgical approaches applied to the correction of cleft lip and palate, emphasizing the advanced techniques and functional results obtained. The literature review consists of a systematized process of identification, selection and interpretation of relevant scientific productions, enabling a broad understanding of the surgical methods used, their advantages, limitations and functional repercussions throughout the rehabilitation process (MARCONI; LAKATOS, 2020).

The research was conducted through a structured search in recognized scientific and technical sources, including articles published in specialized journals, academic books, and clinical guidelines from reference medical and dental societies. Publications published in the last ten years were prioritized in order to ensure the updating and representativeness of scientific findings, although classic works were also consulted to support fundamental concepts. The databases used were PubMed, SciELO, LILACS, Google Scholar, and Cochrane Library, selected for their wide coverage and relevance in the area of plastic surgery, dentistry, and craniofacial rehabilitation (GIL, 2019).

The inclusion criteria included peer-reviewed studies that addressed surgical techniques aimed at the correction of cleft lip and palate, as well as clinical trials, systematic reviews, and meta-analyses that discussed the functional and aesthetic results of the procedures. Technical guidelines and clinical protocols prepared by specialized entities, such as the *American Cleft Palate-Craniofacial Association (ACPA)* and the *Brazilian Society of Plastic Surgery (SBCP),* were also included in order to ensure the technical and scientific basis of the information. Works written in **Portuguese, English and Spanish** were considered, with the aim of expanding the reach and diversity of the sources consulted.

Publications that had a small sample, methodological fragility, absence of peer review, or exclusively opinionated character, without proven scientific support, were excluded. The process of selecting and analyzing the sources followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol, which ensured methodological rigor, transparency, and reproducibility in conducting the review (MOHER et al., 2015).

The analysis of the data obtained was carried out in a critical and comparative manner, seeking to identify convergences and divergences between the results presented in the selected studies. The main surgical techniques described, the success rates and complications reported, and the functional and aesthetic impacts observed in the patients were considered. The information was organized into thematic categories, which included the types of cleft lip and palate, recent surgical innovations, the use of digital technologies in operative planning, and the repercussions on the quality of life and functional rehabilitation of individuals (YIN, 2018).

This methodology enabled the construction of an updated and comprehensive synthesis on the subject, highlighting the most relevant advances in the field of reconstructive surgery and contributing to the improvement of interdisciplinary clinical practice aimed at the treatment of cleft lip and palate.

3 RESULTS AND DISCUSSION

3.1 OVERVIEW OF SURGICAL APPROACHES IN CLEFT LIP AND PALATE

The literature of the last ten years shows significant advances in surgical techniques aimed at the correction of cleft lip and palate, with emphasis on the functional and aesthetic restoration of facial structures. The reviewed publications highlight that therapeutic success depends on individualized planning, considering the type and extent of the cleft, the stage of craniofacial development, and the anatomical particularities of each patient (FONSECA et al., 2021; GARCIA et al., 2022). Among the established techniques, Millard and Tennison-Randall cheiloplasties and double-opposite Furlow palatoplasty and modified von Langenbeck remain widely used, with modifications aimed at optimizing facial symmetry and reducing functional complications (FERNANDES et al., 2020; HUANG et al., 2020).

3.2 ADVANCES IN CHEILOPLASTY TECHNIQUES

In cases of unilateral cleft lip, Millard's rotation-advancement technique is still the most applied, although recent studies have described adaptations that favor better contour of the nasal filter, muscle mobility, and reduction of scar tension.

Sharma et al. (2021) demonstrated that Noordhoff's technique presented superior aesthetic results than Millard's, with less noticeable scars and greater lip symmetry. In both approaches, the preservation of the orbicularis muscle and the adequate redistribution of tensions play an essential role in the quality of the final result.

In addition, the use of three-dimensional (3D) digital planning has contributed to improving flap alignment and surgical predictability (LEE et al., 2021).

3.3 PALATOPLASTY TECHNIQUES AND FUNCTIONAL RESULTS

Palate closure techniques have been improved to reestablish the functioning of the velopharyngeal sphincter, which is essential for phonation and swallowing.

According to Fernandes et al. (2020) and Huang et al. (2020), techniques such as double-opposite Furlow and modified von Langenbeck have been shown to be effective in reducing velopharyngeal insufficiency and improving speech articulation by repositioning the muscle fibers of the soft palate.

Garcia et al. (2022) point out that the ideal timing of surgery directly influences functional results, surgeries performed before 18 months tend to favor proper language development and reduce the need for reoperations.

3.4 FUNCTIONAL IMPACTS: SPEECH, SWALLOWING AND OROFACIAL DEVELOPMENT

The rehabilitation of patients with cleft lip and palate requires special attention to orofacial function, which includes speech, swallowing, and breathing. One of the most reported complications after palatoplasty is velopharyngeal insufficiency, characterized by air escaping from the nasal cavity during speech. Studies indicate that this condition can affect 20% to 30% of patients undergoing primary palate closure (HUANG et al., 2020).

Early speech-language pathology follow-up is essential to correct articulatory alterations and favor velopharyngeal control. Children operated before twelve months tend to have better speech performance and lower hypernasality, compared to those who underwent late surgeries (ROCHA et al., 2021).

In the orthodontic context, the presence of maxillary hypoplasia and malocclusion is frequent among patients with cleft lip and palate. In these cases, surgical treatment can be complemented with distraction osteogenesis, a technique that promotes bone expansion and improves occlusion and facial profile (FREITAS et al., 2021; VARGAS et al., 2020). Thus, functional recovery does not depend exclusively on the surgical technique, but on the integration between surgery, orthodontics and speech therapy, ensuring complete aesthetic and physiological rehabilitation.

3.5 INTEGRATION OF DIGITAL TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE

The application of digital resources in reconstructive surgery represents a milestone in the evolution of current approaches. The use of CAD/CAM systems and 3D virtual planning has allowed the elaboration of personalized surgical guides, resulting in greater precision in incisions, reduced operative time, and improved facial symmetry (LEE et al., 2021).

In addition, artificial intelligence (AI) has been used to predict functional and aesthetic results based on three-dimensional modeling, helping the surgeon to choose the ideal technique for each case (STEVENS et al., 2022). These advances have contributed to increased surgical predictability, improved aesthetic results, and decreased postoperative complications.

3.6 REGENERATIVE APPROACHES AND USE OF BIOMATERIALS

Advances in biotechnology have introduced new therapeutic possibilities. The use of mesenchymal stem cells has been studied as a promising alternative for alveolar bone regeneration in patients undergoing secondary grafts. Xu et al. (2021) reported favorable results regarding bone integration and trabecular density in areas grafted with stem cells, compared to conventional techniques.

At the same time, distraction osteogenesis continues to be an efficient approach in the treatment of maxillary hypoplasia, enabling gradual bone expansion and satisfactory postoperative stability (VARGAS et al., 2020). These strategies highlight the potential of regenerative therapies as complements to traditional reconstructive surgery.

3.7 IMPORTANCE OF THE INTERDISCIPLINARY APPROACH

The reviewed studies reinforce that the correction of cleft lip and palate should be conducted from a multidisciplinary perspective, involving surgeons, orthodontists, speech therapists, psychologists, and other professionals. Rocha et al. (2021) highlight that interdisciplinary treatment favors not only functional rehabilitation, but also the psychosocial development of patients.

The guidelines of the *American Cleft Palate-Craniofacial Association (ACPA)* and the *Brazilian Society of Plastic Surgery (SBCP)* reinforce that therapeutic success depends on continuous and coordinated follow-up from birth to adolescence (GARCIA et al., 2022).

3.8 CRITICAL SYNTHESIS OF FINDINGS

The studies analyzed demonstrate that surgical approaches for cleft lip and palate have evolved considerably in the last decade, incorporating modified techniques,

technological resources, and regenerative therapies that expand the possibilities of functional and aesthetic rehabilitation. Despite the advances, challenges remain related to the standardization of surgical protocols, the heterogeneity of clinical cases, and the need for long-term follow-up to measure the stability of the results.

Thus, it becomes evident that the ideal treatment requires a personalized and interdisciplinary approach, supported by scientific evidence and the integration between technological innovation and clinical practice.

4 CONCLUSION

The present literature review showed that the surgical approach to cleft lip and palate has undergone significant advances in the last decade, reflecting a continuous evolution of reconstructive techniques and rehabilitation protocols. The evidence analyzed demonstrates that the adaptation and improvement of traditional techniques, associated with the development of more conservative and functional surgical methods, have contributed to better aesthetic, functional, and psychosocial results in patients affected by these craniofacial malformations.

The reviewed studies indicate that the success of the treatment is directly related to individualized surgical planning, the appropriate choice of technique according to the type and extent of the cleft, and the opportune timing of the intervention, especially with regard to palatoplasty surgeries. The reduction of velopharyngeal insufficiency, the improvement of speech articulation, and the adequate development of orofacial functions stand out as fundamental outcomes for the quality of life of patients, reinforcing the importance of the functional focus in surgical treatment.

Another relevant aspect identified was the growing incorporation of digital technologies, such as three-dimensional virtual planning, CAD/CAM systems, and artificial intelligence applications, which have increased the predictability of procedures and favored greater anatomical precision. At the same time, regenerative approaches, including the use of stem cells and distraction osteogenesis, are promising strategies for bone reconstruction and correction of maxillary deformities, expanding the therapeutic possibilities in the rehabilitation of patients with cleft lip and palate.

The literature also reinforces that surgical correction alone is not enough to guarantee satisfactory long-term results. The interdisciplinary approach, involving surgeons, orthodontists, speech therapists and other health professionals, is indispensable for comprehensive rehabilitation, contributing not only to orofacial functionality, but also to the psychosocial well-being of affected individuals.

Despite the advances observed, challenges persist related to the standardization of surgical protocols, the heterogeneity of functional assessment methods, and the scarcity of longitudinal studies that follow patients into adulthood. Thus, it is necessary to carry out new research, especially long-term clinical studies, to assess the stability of the results and guide the consolidation of evidence-based practices.

It is concluded that the evolution of surgical techniques, combined with the use of advanced technologies and multiprofessional performance, represents a promising path for improving the treatment of cleft lip and palate. The continuity of scientific research and the integration between technological innovation and clinical practice are essential to optimize functional and aesthetic outcomes, promoting more effective rehabilitation and a better quality of life for patients.

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