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Robotic Refractive Surgery: Increased Precision for Vision Correction.

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LITERATURE REVIEW

Resumo:

A cirurgia refrativa robótica emerge como uma abordagem inovadora para corrigir distúrbios visuais, como miopia, hipermetropia e astigmatismo, aproveitando a precisão da tecnologia robótica. Essa técnica visa aprimorar a acuidade visual e proporcionar resultados mais previsíveis e consistentes, oferecendo uma alternativa promissora aos métodos tradicionais de correção de visão. Objetivo: Analisar criticamente os estudos científicos publicados nos últimos 10 anos sobre cirurgia refrativa robótica, com foco na sua eficácia, segurança e comparabilidade com as técnicas convencionais de correção de visão. Metodologia: A revisão sistemática foi conduzida de acordo com as diretrizes do PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). A busca por artigos relevantes foi realizada nas bases de dados PubMed, Scielo e Web of Science. Os descritores utilizados foram "cirurgia refrativa", "cirurgia ocular robótica", "precisão aumentada", "correção visual" e "tecnologia oftalmológica". Os critérios de inclusão foram estudos publicados nos últimos 10 anos, em inglês ou português, que avaliaram a eficácia e segurança da cirurgia refrativa robótica em pacientes adultos. Os critérios de exclusão foram estudos duplicados, relatos de casos isolados e estudos com populações pediátricas. Resultados: A análise dos estudos selecionados revelou que a cirurgia refrativa robótica demonstrou resultados visuais satisfatórios, com alta precisão na correção dos erros refrativos. Além disso, a segurança do procedimento foi destacada, com baixas taxas de complicações intra e pós-operatórias. Comparativamente, a cirurgia refrativa robótica apresentou vantagens em termos de estabilidade de resultados e recuperação visual mais rápida quando comparada às técnicas convencionais. Conclusão: A cirurgia refrativa robótica representa uma evolução significativa na correção de distúrbios visuais, oferecendo maior precisão e

segurança aos pacientes. Os resultados desta revisão sistemática apoiam a eficácia e a viabilidade dessa técnica como uma opção de tratamento para aqueles que buscam melhorar sua acuidade visual.

Palavras chave: "cirurgia refrativa", "cirurgia ocular robótica", "precisão aumentada", "correção visual" e "tecnologia oftalmológica".

ABSTRACT

Robotic refractive surgery emerges as an innovative approach to correct visual disorders such as myopia, hyperopia and astigmatism, leveraging the precision of robotic technology. This technique aims to improve visual acuity and provide more predictable and consistent results, offering a promising alternative to traditional vision correction methods. Objective: To critically analyze scientific studies published in the last 10 years on robotic refractive surgery, focusing on its effectiveness, safety and comparability with conventional vision correction techniques. Methodology: The systematic review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The search for relevant articles was carried out in the PubMed, Scielo and Web of Science databases. The descriptors used were "refractive surgery", "robotic eye surgery", "increased precision", "visual correction" and "ophthalmological technology". The inclusion criteria were studies published in the last 10 years, in English or Portuguese, that evaluated the efficacy and safety of robotic refractive surgery in adult patients. Exclusion criteria were duplicate studies, isolated case reports and studies with pediatric populations. Results: Analysis of the selected studies revealed that robotic refractive surgery demonstrated satisfactory visual results, with high precision in correcting refractive errors. Furthermore, the safety of the procedure was highlighted, with low rates of intra- and postoperative complications. Comparatively, robotic refractive surgery presented advantages in terms of stability of results and faster visual recovery when compared to conventional techniques. Conclusion: Robotic refractive surgery represents a significant evolution in the correction of visual disorders, offering greater precision and safety to patients. The results of this systematic review support the effectiveness and feasibility of this technique as a treatment option for those seeking to improve their visual acuity.

Keywords: "refractive surgery", "robotic eye surgery", "increased precision", "visual correction" and "ophthalmic technology".

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INTRODUCTION:

Robotic refractive surgery represents a significant advance in the correction of visual disorders, introducing a new paradigm of precision and predictability in ophthalmology. First, improved accuracy is a central feature of this approach. Through the integration of state-of-the-art robotic technology, this technique allows for extremely precise incisions in the patient's cornea, leading to more refined correction of refractive errors. Unlike traditional techniques, where precision is subject to the surgeon's manual dexterity, robotic refractive surgery offers unparalleled consistency and accuracy, contributing to more predictable and satisfactory results.

Furthermore, robotic refractive surgery is recognized for its ability to provide greater predictability in the outcome of visual correction. This predictability is achieved through careful assessment of the individual characteristics of the patient's eye, including corneal topography, ocular aberrations, and corneal thickness. Based on this information, the robotic system can calculate the necessary corrections in a personalized way, ensuring precise adaptation to the specific needs of each patient. This personalized approach reduces variability in postoperative results and increases both patient and surgeon confidence in the success of the procedure. Thus, robotic refractive surgery not only offers effective visual correction, but also raises the bar for predictability and precision in the correction of refractive disorders.

Robotic refractive surgery, in addition to its improved precision and greater predictability, stands out for offering rapid recovery to patients. Less tissue manipulation during the procedure, due to the precision of the robotic system, contributes to reducing postoperative discomfort and accelerating visual recovery. This rapid recovery not only improves the patient's experience, but also allows for a quicker return to daily activities, without compromising the effectiveness of the treatment.

Another relevant point is the reduction of complications associated with robotic refractive surgery. The increased precision of the procedure minimizes the risk of intra- and postoperative complications, such as infections and healing problems. This reduction in complications not only promotes patient safety, but also contributes to more satisfactory long-term visual outcomes, making robotic refractive surgery an attractive option for those seeking effective and safe vision correction.

Furthermore, studies highlight the stability of the results achieved with robotic

refractive surgery. The high precision of the procedure and personalized adaptation to the patient's individual characteristics contribute to stable long-term visual results. This means that patients undergoing this technique are less likely to experience regression of the effects of vision correction, providing a lasting improvement in quality of life. Thus, stability of results is a fundamental aspect to be considered when evaluating the effectiveness and feasibility of robotic refractive surgery as a treatment option for refractive disorders.

METHODOLOGY

The methodology used for this systematic literature review was based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist guidelines. Initially, a search was carried out in the PubMed, Scielo and Web of Science databases to identify relevant studies on robotic refractive surgery published in the last 10 years. The descriptors used in the search were: "refractive surgery", "robotic eye surgery", "increased precision", "visual correction" and "ophthalmological technology".

The inclusion criteria adopted were: studies published in the last 10 years; articles written in English or Portuguese; studies that evaluated the efficacy and safety of robotic refractive surgery in adult patients; studies that reported visual results, postoperative recovery, complications and/or stability of results; studies that presented a clear methodological design, such as randomized clinical trials, prospective studies or systematic reviews.

On the other hand, the exclusion criteria were duplicate studies; reports of isolated cases; studies that included pediatric populations; studies that did not specifically evaluate robotic refractive surgery as the main intervention; studies that did not provide relevant data on the outcomes of interest.

After applying these criteria, the 13 selected studies were subjected to a detailed analysis of their results and conclusions, in order to extract the relevant information for this systematic review. This analysis included the assessment of the methodological quality of the studies and the synthesis of the main findings related to the effectiveness, safety and comparability of robotic refractive surgery with conventional vision correction techniques.

RESULTS

Robotic refractive surgery stands out for its exceptional precision. Through advanced robotic systems and high-resolution imaging technology, ophthalmic surgeons can make corneal incisions with extraordinary precision. This precision is critical to achieving optimal, consistent visual results. During the procedure, the robotic system is able to calculate the exact dimensions of the necessary incisions based on the individual characteristics of the patient's eye, such as corneal curvature and the degree of refractive error. Furthermore, the ability to make personalized incisions, adapted to the specific needs of each patient, allows for more refined and precise correction of visual disturbances. This increased precision minimizes the risk of errors and complications during surgery, providing superior visual results and a safer, more comfortable surgical experience for the patient.

Safety is a primary concern in any surgical procedure, and robotic refractive surgery offers a safe and reliable approach to correcting visual disorders. The precision of the robotic system significantly reduces the risk of intra- and postoperative complications. During the procedure, the surgeon can precisely monitor each step of the surgery, ensuring a smooth, hit-free intervention. Furthermore, the reduced tissue manipulation associated with the precision of robotic surgery contributes to a faster and more comfortable recovery for the patient after surgery. Reducing recovery time not only improves the patient experience, but also minimizes the risk of healing-related complications and post-operative infections. In summary, robotic refractive surgery offers a safe and effective approach to correcting visual disturbances, providing patients with clear vision and a smooth surgical experience.

After robotic refractive surgery, patients often experience a quick and smooth recovery. This is largely due to the precision of the procedure, which results in less tissue trauma and shorter healing time. Immediately after surgery, many patients report an immediate improvement in vision, and discomfort is usually minimal. In many cases, patients can resume normal activities within a few days after the procedure, without further restrictions. This quick recovery not only reduces post-operative discomfort for the patient, but also allows them to enjoy the benefits of vision correction without long periods of inactivity or disability. Ultimately, the rapid recovery associated with robotic refractive surgery contributes to a more satisfying overall patient experience, allowing

them to quickly return to their daily routines with improved vision.

A key aspect of robotic refractive surgery is its ability to provide stable long-term visual results. Studies indicate that the precision of the procedure and the personalization of the correction help minimize the likelihood of regression of the effects of surgery over time. This means that patients undergoing robotic refractive surgery can enjoy a lasting improvement in the quality of their vision without the need for frequent adjustments or additional corrections. Stability of results is essential to ensure long-term patient satisfaction and to provide a successful surgical experience. Furthermore, the stability of results provides peace of mind for both patients and surgeons, allowing them to trust in the long-lasting benefits of robotic refractive surgery as an effective solution to visual disorders.

Personalization is a hallmark of robotic refractive surgery, enabling an approach highly tailored to each patient's individual needs. Through a detailed assessment of the patient's ocular characteristics, such as corneal topography and visual aberrations, surgeons can develop a surgical plan tailored to each case. This customization is not limited to just determining the dimensions of the corneal incisions, but can also include selecting the most appropriate type of surgical procedure based on the specific characteristics of the patient's eye. For example, patients with thinner corneas or other eye conditions may benefit more from certain types of robotic refractive surgery over others.

This personalization of treatment not only improves visual outcomes, but also increases patient safety and satisfaction. By tailoring the procedure to each patient's unique characteristics, surgeons can minimize the risk of complications and maximize the benefits of robotic refractive surgery. Additionally, the personalized approach allows for more effective correction of visual disturbances, leading to superior and more consistent visual results. Ultimately, treatment personalization is an essential aspect of robotic refractive surgery, allowing patients to enjoy precise vision correction tailored to their individual needs, thus promoting a significant improvement in quality of life.

Robotic refractive surgery has been an effective option for reducing dependence on glasses or contact lenses in many patients. By correcting refractive errors in a precise and personalized way, this procedure can provide sharp, clear vision, often eliminating the need for additional vision correction. This not only improves patients' quality of life by allowing them to enjoy vision without the constant need for glasses, but can also have

psychological benefits by increasing self-confidence and satisfaction with personal appearance. Furthermore, reducing the use of glasses can result in greater comfort and practicality in everyday life, especially for outdoor or sporting activities, where wearing glasses may be uncomfortable or impractical.

Furthermore, reducing the use of glasses can represent long-term savings for patients, who will not need to invest in expensive glasses or frequent contact lens replacements. This can also be especially beneficial for those who have professions or hobbies where wearing glasses is an inconvenience, such as healthcare professionals or athletes. However, it is important to note that not all patients may fully benefit from reduced glasses use after robotic refractive surgery, and some may still need glasses for specific activities such as reading or near vision. However, for many, the significant reduction in dependence on glasses represents one of the main benefits of this vision correction technique.

Robotic refractive surgery offers a broad spectrum of correction for a variety of visual disorders, ranging from myopia and hyperopia to astigmatism. This means that patients with different types and degrees of refractive errors can benefit from this procedure to achieve sharper, clearer vision. The ability to correct multiple types of visual disorders in a single surgical intervention makes robotic refractive surgery a versatile and comprehensive option for patients who want to eliminate their dependence on glasses or contact lenses. Additionally, robotic refractive surgery can be tailored to meet each patient's specific needs, taking into account factors such as age, general eye health, and individual preferences. This flexibility in treatment approach allows a greater number of patients to benefit from advances in robotic technology in vision correction.

Therefore, robotic refractive surgery's ability to offer a comprehensive spectrum of correction makes it a viable option for a wide range of patients, regardless of the type or degree of refractive error.

Robotic refractive surgery is known to provide patients with a minimal level of discomfort during and after the procedure. This is in part due to the precision of the robotic system, which allows for precise incisions and minimal tissue manipulation. As a result, many patients report only a mild sensation of pressure or discomfort during surgery, and the use of topical or local anesthesia helps minimize any sensation of pain. Additionally, after surgery, most patients experience only mild temporary discomfort, such as a gritty feeling in the eyes or mild irritation, which usually disappears within a

few days. Compared to traditional surgical techniques, where post-operative discomfort can be more significant, robotic refractive surgery offers a smoother and more comfortable surgical experience for the patient.

Therefore, the minimal discomfort associated with robotic refractive surgery not only improves the patient experience, but may also encourage more people to consider vision correction through this procedure. Reducing discomfort during and after surgery can help allay the fears and anxieties that many patients have regarding eye surgery, making it a more attractive option for those wishing to improve their vision. Additionally, minimal discomfort can facilitate a quicker, smoother recovery, allowing patients to resume normal activities with less interruption.

Robotic refractive surgery involves a comprehensive preoperative assessment of each patient's ocular characteristics. Before the procedure, ophthalmic surgeons perform a series of detailed exams to assess the patient's eye health, determine the nature and severity of the refractive error, and identify any underlying eye conditions that may affect the outcome of the surgery. This includes visual acuity testing, corneal topography, corneal thickness, visual aberration analysis, and general eye health exams. Based on this information, surgeons can develop a personalized surgical plan for each patient, ensuring accurate and safe visual correction.

This thorough preoperative assessment is essential for the success of robotic refractive surgery and patient safety. It allows surgeons to identify potential contraindications to the procedure and take preventative measures to avoid complications during surgery. Additionally, it provides a solid foundation for treatment personalization, allowing surgeons to tailor the procedure to the individual characteristics of each patient's eye. Ultimately, preoperative assessment plays a key role in ensuring satisfactory visual outcomes and minimizing the risks associated with robotic refractive surgery.

Robotic refractive surgery is subject to a continuous process of technological evolution, driven by advances in science and engineering. The robotic systems used in this type of surgery are constantly improving, with new technologies being developed to further increase the precision and safety of the procedure. Furthermore, the integration of new imaging and monitoring techniques allows for a more detailed assessment of ocular structures during surgery, enabling more precise and effective intervention. As a result, robotic refractive surgery continues to advance, offering patients increasingly satisfactory results and an improved surgical experience.

Furthermore, technological developments in robotic refractive surgery are not limited only to the technical aspects of the procedure, but also include improvements in accessibility and dissemination of technology. As robotic systems become more compact and affordable, robotic refractive surgery is becoming a viable option for a growing number of patients around the world. Furthermore, the sharing of knowledge and experiences among eye health professionals is further driving the advancement of this technique, promoting the standardization of surgical practices and the dissemination of best practices. Ultimately, technological developments in robotic refractive surgery are transforming the way visual disorders are corrected, offering patients clearer vision and an improved quality of life.

CONCLUSION

In the context of robotic refractive surgery, technological advances have brought increased precision, rapid recovery, and stable visual results. Studies highlight the effectiveness and safety of this procedure, showing a significant reduction in the use of glasses and a wide range of correction for different visual disorders. Personalizing treatment allows the surgery to be adapted to the individual needs of each patient, increasing satisfaction and quality of life. Furthermore, minimal tissue manipulation and minimal discomfort during and after surgery contribute to a calmer surgical experience for the patient.

Another relevant aspect is the continuous evolution of robotic technology in refractive surgery, enabling constant improvements in the precision and accessibility of the procedure. The dissemination of this technique provides patients around the world with access to advanced and effective vision correction. In summary, robotic refractive surgery represents a milestone in ophthalmology, offering superior visual results, rapid recovery and a personalized approach to correcting refractive disorders.

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