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Effectiveness of contemporary surgical approaches and prosthetic rehabilitation in the management of ameloblastoma: a narrative review of functional and aesthetic outcomes

Eficacia de los abordajes quirúrgicos contemporáneos y la rehabilitación protésica en el tratamiento del ameloblastoma: una revisión narrativa de los resultados funcionales y estéticos

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ABSTRACT

Ameloblastoma, a benign yet aggressive odontogenic tumour poses significant challenges in management due to its potential for recurrence and impact on oral functionality and aesthetics. Effective treatment necessitates a combination of surgical resection, bone reconstruction, and prosthetic rehabilitation. This review aims to evaluate contemporary surgical approaches and prosthetic rehabilitation strategies for managing ameloblastoma, focusing on functional and aesthetic outcomes to enhance patient recovery and quality of life. A narrative review was conducted using scholarly databases, incorporating articles published in English from 2013 to 2023. Studies were selected based on their focus on surgical approaches and prosthetic rehabilitation outcomes. A systematic framework categorized surgical techniques (radical, conservative) and prosthetic methods (fixed, removable, or implant-supported). Radical segmental resection with sufficient safety margins emerged as the preferred surgical approach to minimize recurrence. Immediate reconstruction using autogenous bone grafts, particularly vascularized fibula free-flaps, demonstrated high success rates and improved quality of life. Implant-supported prosthetics showed enhanced functional and aesthetic recovery, with immediate implants yielding better survival rates. Technological advancements such as CAD/CAM and 3D printing improved surgical precision and patient outcomes. Contemporary surgical and prosthetic advancements significantly enhance the management of ameloblastoma. Integrating innovative techniques with long-term follow-up ensures optimal functional and aesthetic results, contributing to improved patient satisfaction and recovery.

Keywords: Ameloblastoma. Bone Reconstruction. Dental Prosthesis. Reconstructive Surgical Procedures. Functional Recovery.

RESUMEN

El ameloblastoma, un tumor odontogénico benigno pero agresivo, plantea importantes desafíos en el tratamiento debido a su potencial de recurrencia y su impacto en la funcionalidad y la estética bucal. El tratamiento eficaz requiere una combinación de resección quirúrgica, reconstrucción ósea y rehabilitación protésica. Esta revisión tiene como objetivo evaluar los enfoques quirúrgicos contemporáneos y las estrategias de rehabilitación protésica para el tratamiento del ameloblastoma, centrándose en los resultados funcionales y estéticos para mejorar la recuperación y la calidad de vida del paciente. Se realizó una revisión narrativa utilizando bases de datos académicas, incorporando artículos publicados en inglés entre 2013 y 2023. Los estudios se seleccionaron en función de su enfoque en los abordajes quirúrgicos y los resultados de la rehabilitación protésica. Un marco sistemático categorizó las técnicas quirúrgicas (radical, conservadora) y los métodos protésicos (fijos, removibles o implantosoportados). La resección segmentaria radical con suficientes márgenes de seguridad surgió como el abordaje quirúrgico preferido para minimizar la recurrencia. La reconstrucción inmediata utilizando injertos óseos autógenos, particularmente colgajos libres de peroné vascularizados, demostró altas tasas de éxito y mejor calidad de vida. Las prótesis implantosoportadas mostraron una mejor recuperación funcional y estética, y los implantes inmediatos produjeron mejores tasas de supervivencia. Los avances tecnológicos como CAD/CAM y la impresión 3D mejoraron la precisión quirúrgica y los resultados de los pacientes. Los avances quirúrgicos y protésicos contemporáneos mejoran significativamente el tratamiento del ameloblastoma. La integración de técnicas innovadoras con un seguimiento a largo plazo garantiza resultados funcionales y estéticos óptimos, lo que contribuye a mejorar la satisfacción y la recuperación del paciente.

Palabras clave: Ameloblastoma. Reconstrucción ósea. Prótesis Dental. Procedimientos quirúrgicos reconstructivos. Recuperación funcional.

INTRODUCTION

Ameloblastoma is an odontogenic tumour that makes up approximately 1% of all oral cavity cancers, with an incidence of 0.5 per million persons per year This benign tumourr is equally prevalent in males and women, usually developing in the third to fifth decades, and occurring in the jaw 80% of the time and the maxillary 20% of the time (Ooi et al., 2014). The origin could be the dental sheet, the enamel organ, the mouth cavity's stratified squamous epithelium, or the embryonic remains of odontogenic cysts. No known pathophysiology exists. Numerous factors, such as inflammation, long-term stress, malnutrition, vitamin deficiencies, and a possible link to HPV, have been implicated in the process (Adebayo et al., 2011). It is a tumour that rarely spreads and grows slowly. It could lead to the destruction of the cortical bone. Pain, asymmetry, agglutination and speech, malocclusion, loss of dental fragments, and paresthesia, if the lower alveolar nerve is affected, are all consequences of invasion of the surrounding soft tissue (Sham et al., 2009).

Ameloblastomas can occur in people of any age, however,r they most commonly affect those between the ages of 20 and 40 (Mahmoud et al., 2018). They are uncommon in children younger than ten. The effects are equally felt by men and women. Ameloblastomas are more commonly detected in the posterior mandible, but fetumourssmors grow in the maxilla. Neagu et al. conducted a population-based study to determine the incidence rate and absolute survival of malignant ameloblastoma. Their examination of 293 people across the country showed that the yearly incidence rate of malignant ameloblastoma was 1.79 per 10 million (Neagu et al., 2019). Black people had a higher incidence rate than white people, and males had a higher incidence rate than females. They also found that malignant ameloblastomas, which comprise both metastasizing and ameloblastic carcinoma, account for 1.6 to 2.2% of all odontogenic tumourss. Their findings corroborated previous epidemiologic research that indicated the male-to-female ratio varied between 2.3 and 5 (Palanisamy & Jenzer, 2023). Orthopantomography is usually performed when a patient seeks therapy for a problem or an unintentional diagnosis. Since the results are not pathognomonic, a histological examination should be conducted to confirm the lesion (3).

Despite being one of the most common odontogenic neoplasms, AM is still very challenging for surgeons to manage (Hammarfjord et al., 2013). Some studies found that the recurrence rate was higher for patients receiving careful treatment as opposed to severe treatment (Hendra et al., 2019) (Troiano et al., 2017). For this kind of tumour, surgical resection remains the preferred treatment. Depending on the tumour size this may involve segmental or marginal resection with or without disarticulation, as well as recurring long-term follow-up (> 10 years). Furthermore, it has been demonstrated that surgically treating AM greatly enhances patients' quality of life (Lawal et al., 2016). Additionally the resulting anatomical bone defect is repaired using bone graft biomaterials like autogenous grafts (derived from the same individual), which can be either vascularized free flaps or non-vascularized bone grafts; allogenic grafts (derived from another individual of the same species); xenogeneic grafts (acquired from other species); alloplastic grafts (commercially prepared); and customized grafts (using active biomolecules to regenerate bone) (Janjua et al., 2022). Adequate safety margins of 1.5 to 2 cm are recommended to avoid possible recurrence. Patients with AM may benefit from implant-supported prosthetic rehabilitation with a fixed dental prosthesis (either cemented, screw-retained, or hybrid) and/or a removable dental prosthesis. Primary placement of dental implants occurs during surgery, while secondary placement occurs following the completion of surgical therapy (Kumar et al., 2016).

It has been shown that initial placement of dental implants for prosthetic rehabilitation is more beneficial for patients with oral cancer, with a 5-year survival rate of 92.8% compared to secondary placement of 86.4% (Alberga et al., 2021). Furthermore, compared to previously irradiated areas, a higher survival rate has been seen in implants that were implanted immediately (In 'T Veld et al., 2021) and later (Camolesi et al., 2023) and that had not received radiotherapy. However, a recent thorough study and meta-analysis revealed that the overall survival rate was 97% after one year of prosthesis loading following surgically excising oral malignancies and employing fibula free-flap to rebuild the mandible. In 69% of the tumours analyzed in this study, AM was found. As part of the secondary aims, the authors also demonstrated a 98% survival rate with immediate implants and a 97% survival rate with delayed implantation (Illand et al., 2023). However, little is known about the survival rate of dental implants and the subsequent implant-supported rehabilitation in surgically treated AM patients. This review evaluates current surgical procedures and prosthetic rehabilitation for ameloblastoma, with a focus on their functional and aesthetic outcomes. With a focus on how surgical resection, bone restoration, and implant-supported prosthetics can improve a patient's quality of life and recovery after ameloblastoma therapy, it aims to provide insight into effective treatment strategies.

METHODOLOGY

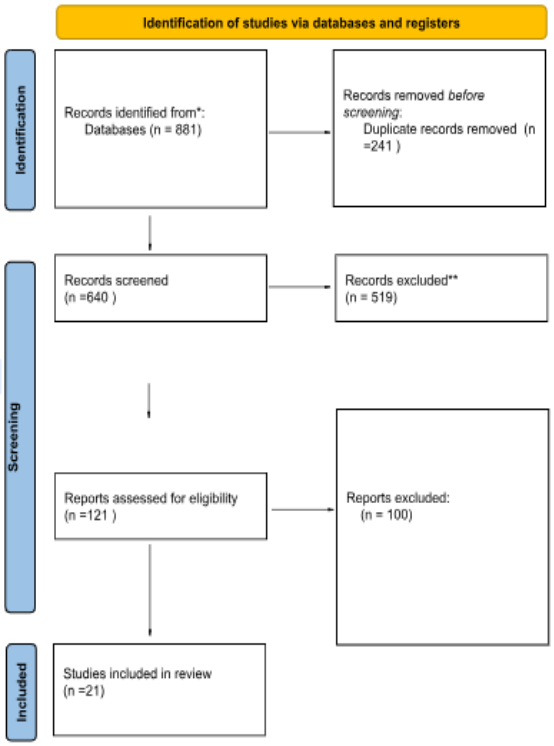
This narrative review adopts an integrative approach, systematically examining and evaluating relevant materials sourced from scholarly databases such as ScienceDirect, Google Scholar, and PubMed. The methodology follows a

comprehensive review framework, incorporating modifications from established review methods in the context of surgical management and prosthetic rehabilitation for ameloblastoma. The review process began with the use of specific search terms like "ameloblastoma," "surgical approaches," "prosthetic rehabilitation," "functional outcomes," and "aesthetic outcomes." Boolean operators such as "AND" and "OR" were utilized to refine and focus the search queries, ensuring the retrieval of pertinent literature.

Inclusion and Exclusion Criteria

This review involved research articles highlighting modern surgical techniques and prosthetic treatment of ameloblastoma, published in the English language in the last decade (2013 to 2023). Only research articles relevant to the functional and aesthetic outcomes of the patients after the treatment were considered. Studies with animals, confounded results, cynosures quarter-wave or otherwise methodologically unsound were eliminated. The initial search using titles and abstracts for this study returned 1,322 articles. Out of these, through meeting inclusion and exclusion criteria, 215 articles were considered for further review. After full-text articles screening, there were 68 papers included in this review, which provided significant information about the outcomes of present surgical operations and prosthetic reconstruction for ameloblastoma. The literature review was categorized starting from innovative surgical approaches, followed by reconstructive methods and last but not least the prosthetic rehabilitation protocols. Surgical interventions were divided into purely radical and conservative while prosthetic schemes were divided according to the type of prosthesis fixed, removable or implant supported. This categorisation made it easier to understand all these various developments individually and compare functional and esthetic results among the various studies.

Figure 1. PRISMA Flow Diagram



Source: the authors.

RESULTS AND DISCUSSION

Surgical approaches

Segmental Resection and Reconstruction

In the study by Ooi et al. patients with unicystic or multicystic ameloblastomas number 30, underwent segmental

resection of the part of the mandible affected by a tumour and further received the free peroneal flap (Ooi et al., 2014). There was no sign of this procedure recurring after a follow-up of five years, which makes this outcome quite successful. The outcomes proved sufficient functional and esthetic outcomes, even with the low incorporation of osseointegrated oral implants. According to the authors, it can be concluded that such procedures as virtual surgical planning and other modern technologies could provide more satisfactory facial symmetry and the need for the next operations (Ooi et al., 2014). This approach supports the assertion that, in a nutshell, complete ameloblastoma reconstruction is crucial to handling multifaceted lesional scenarios.

Radical Segmental Resection for Solid and Multicystic Ameloblastomas

In a review of 58 articles undertaken by Pogrel et al. (6), simple enucleation in solid and multicystic ameloblastomas had a recurrence rate of 60-80% (Pogrel & Montes, 2009). On this basis, the authors suggested that segmental resection with a 1 cm margin around the lesion, including both the bone and soft tissue, is the treatment of choice for these more aggressive forms of ameloblastoma. For unicystic ameloblastomas, enucleation appeared reasonable; however, block resection with a 0.5-1 cm margin could be applied if enucleation was impracticable. This study emphasises the need for radical surgery and adequate clearance of the margins to decrease the chances of the disease and improve overall survival (Pogrel & Montes, 2009).

Segmental Resection with Immediate Reconstruction

The study by Bianchi et al. (5) described 31 patients who had large Ams suffering especially from a mandibular branch in this case. The authors advised thatt segmental resection with immediate reconstruction was the optimal option for treatment (Bianchi et al., 2013). It was shown that this technique provided better esthetic and functional results, and recurrence was reduced. Also, the authors stressed that immediate dental implants should become a part of the treatment strategy as their absence may lead to long-term deficits for the young patient. Enhanced reconstruction has been described as being an important key in managing large complex ameloblastomas without undue compromise on form and function (Bianchi et al., 2013).

Radical Surgery with Reconstruction for Extensive Ameloblastomas

Sharma et al. justified the use of surgical intervention with immediate reconstruction in patients with widespread ameloblastomas (Sharma et al., 2012). The authors made a note of emphasis against mandibulectomy without reconstruction due to the large morbidity level that the patients exhibited in terms of oral and facial functions as well as psychological issues (Sharma et al., 2012). The paper also emphasizes the objective of reconstructive methods aimed at restoring not only the morphological aspect of the mandible butt albut so physiological functions, which contributes to a higher quality of life in patients (Sharma et al., 2012). In addition to minimizing the mechanical stress of an operation, reconstruction helps to treat the psychological aftermath that can occur after significant resection of tissue and injury to the face. Usibayo et al. case report of a patient with ameloblastoma who underwent radical surgery followed by recurrence in the soft tissue after my-oners (Adebayo et al., 2011). This emphasizes the possibility of very late recurrences thus the need for lifelong follow-up of surgical patients with ameloblastoma by radiology. The authors also argued the need to perform imaging after several years or even decades to observe any signs of a relapse, showing that surveillance should remain an important aspect of a patient's follow-up after completion of the treatment (Adebayo et al., 2011). Recurrent intrabody ameloblastomas were treated and in light of that Hammarfjord et al., recommended radical treatment if the tumour was near sensitive structures. Conservative treatment that defines less invasive procedures and resections was considered appropriate for small intrabony ameloblastomas with no signs of recurrence (Hammarfjord et al., 2013). However, the authors stated a fact that conservative treatment needs to be commenced with follow-up for up to ten years to check for any relapse. This work is in line with current ideas about the individual approach to tumour treatmentt depending on its size and position and the general state of the patient's health (Hammarfjord et al., 2013).

Technological Advancements in Surgical Procedures

In their review, Hou et al. have describedd CAD-CAMAM applications surgical planning in detail Although the authors used the term 'titanium' instead of 'titanium alloys,' their work has been included here in this subsection because the use of alloy mentioned in this section is usable for titanium also (Hou et al., 2012). These methods offer a better understanding of surgical defects and they also contribute towards shortening of surgery time, amount of blood lost and flap ischemia. 3D models were also presented as a cost-saving option mainly for less extensive ameloblastomas, where the defect is better

illustrated (Chukwuneke et al., 2010). This novel strategy in maxillofacial surgery leads to improved surgical planning and enhancement of operative results, especially in extensive operations since issues of risk and magnitude of the operation are controlled for. These observations afford insight into how modern surgical procedures, coupled with technology, are gradually revolutionizing the approach to ameloblastoma management (Chukwuneke et al., 2010). Compared to a complete mastectomy without immediate reconstructive surgery, the utilization and combination of radical surgery with immediate reconstruction and long-term follow-uhahaves a dramatic impact on the patient's prognosis and the likelihood of recurrence. Furthermore, advanced technologies like computer-aided design computer-aided manufacturing and 3D Printing are customers of the accuracy and efficiency of operations (Chukwuneke et al., 2010).

Prosthetic Rehabilitation

Autogenous bone graft

Complicated reconstructive techniques are required to address secondary defects of the oral and maxillofacial region that arise as a result of radical surgical procedures to achieve oral rehabilitation, which is to return the patient's symmetry and functionality as close to their premorbid state as possible, and, consequently, improve their quality of life. These flaws often lead to significant practical and cosmetic changes (Ettinger et al., 2023). The results of our investigation are consistent with scientific data showing that the most popular autogenous bone graft for correcting orofacial anatomical defects after surgery is the vascularized fibula free-flap (Abbate et al., 2023). This flap type's bicortical architecture, big vascular pedicle that easily adapts to the jaw, and enough bone length increase the primary fixation of dental implants (Ooi et al., 2014). The most frequent issues with this kind of graft are flap loss, skin graft loss at the donor site, wound dehiscence and infection, and percutaneous fistulas (Paranque et al., 2011), even though it has been demonstrated to have excellent success rates (91%) (Asif Shah et al., 2019). Furthermore, it has been shown that these patients have a significant improvement in their quality of life about their dental health (Qayyum et al., 2023). Finally, new technologies such as virtual surgical planning using 3D models and cone beam computed tomography are expected to allow for more precise reconstructions, reducing the risk of postoperative complications and favouring later implant-supported prosthetic rehabilitation.

Dental implants for prosthetic rehabilitation

Primary dental implant placements are more beneficial for prosthetic rehabilitation for cancer patients (In 'T Veld et al., 2021) and for patients who have not received radiation therapy compared to previously irradiated sites (Camolesi et al., 2023), with a 5-year survival rate of 92.8% compared to secondary placement (86.4%). Patients who underwent surgery for head and neck cancer had a good chance of survival, according to Wuster et al. (Wüster et al., 2023). Vestibuloplasty patients had a considerably higher survival and implant success rate of 100% after five years, compared to 99.1% and 93.1%, respectively, that patients without the procedure reported after three and five years. Six more implants were lost over the monitoring period. For patients with head and neck cancers, the authors recommend that vestibuloplasty be considered at all times and employed when the anatomical situation warrants it to achieve high implant success rates. In individuals with systemic autoimmune illnesses that impact the oral cavity, dental implants have demonstrated an excellent survival rate The survival rate for dental implants in lichen planus patients was 98.3% after a 44.6-month follow-up. When individuals with epidermolysis bullosa were 32.6 months old, the rate was 98.7% The percentage of those with Sjögren's syndrome standing at 45.2 months was 94.2% (Mosaddad et al., 2023). In individuals with systemic sclerosis, the rate was 97.7% after 37.5 months. After 24 months, it was 100% in those with pemphigus and systemic lupus erythematosus Although there appears to have been no significant impact of the autoimmune condition on the survival rate of dental implants, a comprehensive risk assessment is recommended before starting implant therapy (Mosaddad et al., 2023).

Hybrid Prosthetic Restorations for Alveolar Reconstruction

Stable anchoring of permanent and/or removable implant-supported dental prostheses provides efficient clinical treatment options for patients with partial dentition (Tsigarida & Chochlidakis, 2021). To achieve a suitable osseointegration process, implants should be immersed in the bone without any type of stress for three to four months (early loading) or up to six to eight months (conventional/late loading) (Al-Sawai & Labib, 2016). The traditional approach was the one that doctors in the present study used the most, even though rapid loading—the placement of the temporary or permanent dental implant on the same day of surgery—has benefited from a shorter treatment period. Current available randomized clinical trials suggest that this approach carries a higher chance of implant failure (Chen et al., 2019). Fast insertion or professionalization requires good initial implant stability (> 35 N/cm2), and a patient's prognosis will be better if the implant stability coefficient

value is more than 60. However, good primary stability is not always possible and can be affected by several factors such as local anatomy, bone density, implant milling technique, and macro-design (Carosi et al., 2023) (Rathi et al., 2023). Finally, hybrid prosthetic restorations are an excellent option for repairing alveolar ridges with moderate to severe resorption. They are comparable to a screw-retained structure with zirconia, porcelain, and lithium disilicate cemented crowns. These restorations splint the implants together, provide enough resistance, and meet aesthetic standards (Niakan & Yaghoobi, 2021)(Garrido-Martínez et al., 2021) (Ettinger et al., 2023).

Ameloblastoma, a benign but aggressive odontogenic tumour, presents significant challenges in management due to its recurrence potential and impact on functional and aesthetic outcomes. Surgical intervention remains the cornerstone of treatment, with a variety of techniques employed based on tumour size, location, and aggressiveness. This narrative review aimed to evaluate contemporary surgical approaches and prosthetic rehabilitation strategies, emphasizing their effectiveness in ameloblastoma management.

The findings of Ooi et al. (2014) underscore the effectiveness of segmental resection combined with free peroneal flap reconstruction in ameloblastoma treatment. In their cohort of 30 patients, the absence of recurrence after five years highlights the success of this approach, particularly in the management of unicystic and multicystic ameloblastomas (Ooi et al., 2014). The inclusion of virtual surgical planning further improves aesthetic outcomes by enhancing facial symmetry and minimizing the need for additional surgeries. Additionally, Pogrel et al. (2009) emphasized the higher recurrence rates associated with conservative treatments, suggesting that radical segmental resection with clear safety margins is the preferred method for solid and multicystic forms of ameloblastoma. These findings align with the view that radical surgery, with a 1 cm margin, offers superior long-term outcomes by reducing the risk of recurrence (Pogrel & Montes, 2009).

Segmental resection combined with immediate reconstruction is also supported by Bianchi et al. (2013), who found that this approach provided improved aesthetic and functional outcomes. The inclusion of immediate dental implants was particularly beneficial for younger patients, preserving oral function and preventing long-term deficits. These results are consistent with the broader literature advocating for immediate reconstruction to minimize post-surgical complications and ensure the restoration of both form and function (Bianchi et al., 2013).

Technological advancements, particularly in computer-aided design (CAD) and manufacturing (CAM), have further optimized surgical procedures. Hou et al. (2012) highlighted the role of 3D-printed models in planning and executing complex surgeries, which has proven beneficial in reducing surgical time, blood loss, and complications (Hou et al., 2012). These innovations contribute significantly to improving surgical precision and patient outcomes, as evidenced by the enhanced success rates observed with contemporary methods.

Prosthetic rehabilitation plays a crucial role in restoring oral function and aesthetics following surgical treatment for ameloblastoma. The use of autogenous bone grafts, particularly the vascularized fibula-free flap, has been widely adopted due to its high success rate and suitability for complex reconstructions. Studies show that the fibula-free flap offers adequate bone length and stable fixation for dental implants, leading to improved functional and aesthetic outcomes (Sharma et al., 2012). Furthermore, the use of secondary prosthetic rehabilitation through dental implants has proven to significantly enhance the quality of life for patients. The 5-year survival rate for implants placed immediately during surgery is notably higher (92.8%) compared to secondary placement (86.4%) (Hou et al., 2012) suggesting that primary placement offers superior long-term outcomes.

While the studies reviewed provide valuable insights, several limitations should be considered. The majority of the studies involved relatively small sample sizes, limiting the generalizability of the results. Moreover, many studies lacked long-term follow-up, which is crucial for assessing the recurrence rates of ameloblastomas and the durability of prosthetic rehabilitation Additionally, the variability in surgical techniques and prosthetic approaches across different studies makes it difficult to draw definitive conclusions regarding the superiority of one method over another. The studies also primarily focus on the clinical outcomes, with limited emphasis on the psychological impact of the surgery and rehabilitation (Sharma et al., 2012). Given that ameloblastoma treatment often results in significant facial disfigurement, the psychological aspects of recovery, including patient satisfaction and quality of life, warrant further investigation (Pogrel & Montes, 2009). In conclusion, contemporary surgical approaches, including segmental resection and immediate reconstruction, combined with prosthetic rehabilitation, significantly improve functional and aesthetic outcomes in ameloblastoma management. However, further research with larger cohorts, long-term follow-up, and a focus on psychological recovery is essential to optimize treatment protocols for this challenging condition.

CONCLUSION

In conclusion, contemporary surgical approaches and prosthetic rehabilitation for ameloblastoma have significantly

improved patient outcomes, both functionally and aesthetically. Surgical excision with primary reconstruction as in compound radial forearm flap and fibula free flap reconstruction have a good prognosis and rarely recurring. Moreover, CAD/CAM and 3D printing in surgical procedures improved accuracy does not cause complications and shortens the healing process. Another add-on to prosthodontic rehabilitation, especially dental implant prosthesis, maintains oral function and enhances quality of life. However, there are still some limitations: the likelihood of late recurrence indicates further requirements for patients' follow-up, as well as targeted therapies.

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