

## Comparative efficacy of microimplant-assisted rapid palatal expansion versus surgically assisted rapid palatal expansion in the treatment of maxillary transverse discrepancy

Eficacia comparativa de la expansión palatina rápida asistida por microimplantes versus la expansión palatina rápida asistida quirúrgicamente en el tratamiento de la discrepancia transversal maxilar

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### ABSTRACT

**Background:** The maxillary transverse discrepancy is an arch-length reduction that has an unsatisfactory effect on the aesthetics of the face and position while resulting in functional damage. Because of these variations, the goal of this study is to assess the efficacy, stability, and potential adverse effects of Microimplant-Assisted Rapid Palatal Expansion (MARPE) and Surgically Assisted Rapid Palatal Expansion (SARPE) in MTD in adolescents and adults. **Methods:** An electronic search was conducted in five distinct databases, and the findings contained only peer-reviewed literature from 2018 to 2024. Randomised controlled studies comparing the efficacy of MARPE and SARPE in inducing skeletal and dental alterations, treatment stability, and relapse rates were among the study selection criteria. Data extraction included a review of patient demographics, types of therapies provided, outcomes obtained, and side effects noted. **Results:** The findings of the study demonstrate that both procedures are appropriate for the treatment of MTD, but MARPE provides advantages in terms of morbidity and patient satisfaction, whilst SARPE may provide faster and more stable outcomes in some circumstances. This study encourages doctors to consider individual patient needs before determining which maxillary transverse discrepancy treatment strategy to use. **Conclusion:** This study discovered that the MARPE has superior skeletal results and stability than the SARPE, albeit with a higher risk of surgical complications. It is critical to ensure that the unique patient population is carefully selected.

**Keywords:** Maxillary transverse discrepancy. Microimplant-assisted rapid palatal expansion. Surgically assisted rapid palatal expansion.

### RESUMEN

**Introducción:** La discrepancia transversal maxilar es una reducción de la longitud del arco que tiene un efecto insatisfactorio en la estética de la cara y la posición, al tiempo que produce daño funcional. Debido a estas variaciones, el objetivo de este estudio es evaluar la eficacia, estabilidad y posibles efectos adversos de Expansión palatina rápida asistida por microimplantes (MARPE) y Expansión palatina rápida asistida quirúrgicamente (SARPE) en MTD en adolescentes y adultos. **Métodos:** Se realizó una búsqueda electrónica en cinco bases de datos distintas y los hallazgos contenían solo literatura revisada por pares de 2018 a 2024. Entre los estudios controlados aleatorios que comparaban la eficacia de MARPE y SARPE para inducir alteraciones esqueléticas y dentales, la estabilidad del tratamiento y las tasas de recaída se encontraban Criterios de selección de estudios. La extracción de datos incluyó una revisión de la demografía de los pacientes, los tipos de terapias proporcionadas, los resultados obtenidos y los efectos secundarios observados. **Resultados:** Los hallazgos del estudio demuestran que ambos procedimientos son apropiados para el tratamiento de la MTD, pero MARPE ofrece ventajas en términos de morbilidad y satisfacción del paciente, mientras que SARPE puede proporcionar resultados más rápidos y estables en algunas circunstancias. Este estudio alienta a los médicos a considerar las necesidades individuales de los pacientes antes de determinar qué estrategia de tratamiento de discrepancia transversal maxilar utilizar. **Conclusión:** Este estudio descubrió que el MARPE tiene resultados esqueléticos y estabilidad superiores que el SARPE, aunque con un mayor riesgo de complicaciones quirúrgicas. Es fundamental garantizar que se seleccione cuidadosamente la población única de pacientes.

**Palabras clave:** Discrepancia transversal maxilar. Expansión palatina rápida asistida por microimplantes. Expansión palatina rápida asistida quirúrgicamente.

## INTRODUCTION

The maxillary transverse discrepancy, a frequent malocclusion, can significantly impact facial aesthetics and function (Dakhil et al., 2021; Nowak et al., 2020). It can cause a variety of clinical symptoms, including dental crowding, a restricted nasal cavity, a high palatal vault, and UCL or LCL posterior crossbite (Evangelista et al., 2020; Andruccioli et al., 2020). Patients with MTD often have a narrower airway compared to those with normal maxillary width, impacting craniofacial growth and health (Ye et al., 2024). It has also been discovered to be connected with Obstructive Sleep Apnea (OSA), which is significant in any orthodontic treatment (Vinha et al., 2020; Wright et al., 2023).

The impact of the maxillary transverse deficit on dental function and aesthetically pleasing outcomes necessitates its treatment. Eliminating this gap is crucial not only for occlusal functions but also for improving airway diameters and overall patient states (Alleman et al., 2019; Trevisiol et al., 2022). The maxillary transverse deficit has previously been treated by rapid palatal expansion (RPE), which involves extending the width of the maxilla by removing the mid-palatal suture (Chun et al., 2022; Kapetanovic et al., 2023). However, in mature patients, the RPE rate may be insufficient due to higher skeletal resistance of the midpalatal suture, potentially leading to complications such as root resorption and buccal cortex dehiscence (Barbedo et al., 2021; Kapetanovic et al., 2023; Sermboonsang et al., 2020).

To meet these issues, two sophisticated surgical techniques have emerged, Surgically enabled rapid palatal expansion and micro implant-supported rapid palatal expansion. The surgically enabled rapid palatal expansion has shown promising outcomes for treating skeletal growth in older patients, but the high cost and risks may discourage patients from accepting the treatment (Kapetanovic et al., 2023; Inchingolo et al., 2022; Winsauer et al., 2021; Araque et al., 2022). However, micro-implant-supported rapid palatal expansion provides an inferior choice by anchoring the skeletal bones with orthodontic micro-implants (Bucur et al., 2021; Park et al., 2024). This method supports increased maxilla and mandible length while reducing morbidity in dentoalveolar tissues (Hoque et al., 2021; Hsu et al., 2023). Orthodontic micro-implants are a less intrusive way to surgically augment rapid palatal expansion (RPE) anchoring needs than traditional micro implant-assisted rapid palatal expansion (MARPE). Unlike other forms of treatment, this strategy not only promotes the increase in the length of the facial bones but also helps to prevent any harm to the dentoalveolar structures (Solano et al., 2022; Hoque et al., 2021; Hsu et al., 2023).

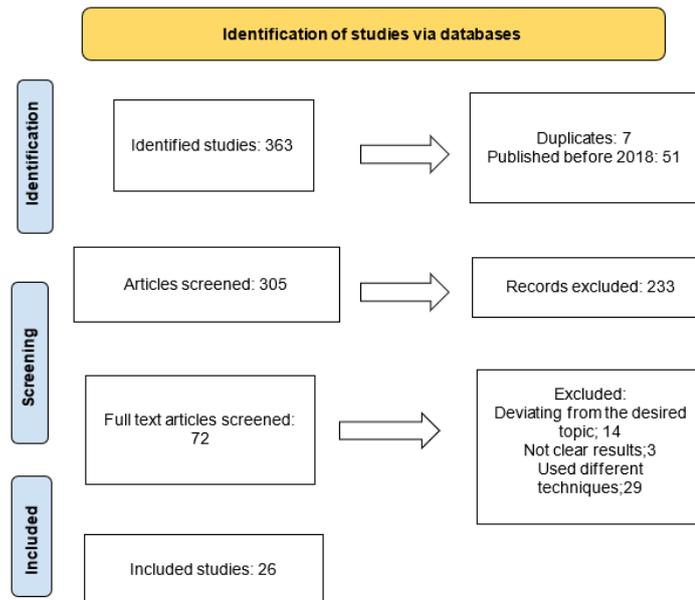
Surgically assisted rapid palatal expansion, or SARPE, is a surgery commonly used for major face MTD; however, it is more dangerous and requires a longer recovery period. Because it offers benefits including shorter residual times and fewer penalties, Microimplant-Assisted Rapid Palatal Expansion (MARPE) has been promoted as an upgrade in recent years for several reasons. However, MARPE's key characteristics have improved its application in orthodontic therapy and highlight the necessity for comparison research with SARPE. By examining research on the efficacy, predictability, patient satisfaction, and complications of MARPE and SARPE, the current study seeks to close this gap. The findings of the study will assist medical professionals in choosing the best treatment approach for patients with maxillary transverse deficiencies.

The objectives of the study are to examine the clinical efficacy of MARPE and SARPEs in controlling maxillary width, To examine the stability of the results and how often corrections relapse after treatment for both methods and to highlight potential issues and negative consequences of MARPE and SARPE.

## METHODOLOGY

### Search strategy

Electronic databases were examined to find studies that compared MARPE and SARPE in the treatment of maxillary transverse deficit. We used a combined strategy to look for pertinent PubMed and Google Scholar sources. The index terms that were used in the search were both keywords and fixed terminology. The following terms were used: "maxillary expansion," "maxillary transverse discrepancy," "MARPE," "SARPE," "Microimplant-Assisted Rapid Palatal Expansion," and "Surgically Assisted Rapid Palatal Expansion." To find current data, the current study concentrated on papers published in the English language between 2018 and 2024. Additionally, the authors personally searched the bibliographies of the chosen papers to find any that might not have been found by the database search. This thorough search approach aided in the recovery of every publication that compared the SARPE and MARPE processes as shown in the following diagram.

**Figure 1. Identification of studies via databases**

Source: the authors.

### Inclusion exclusion criteria

This study sampling parameters encompassed all studies that evaluated the efficacy of Microimplant-Assisted Rapid Palatal Expansion (MARPE) and Surgically Assisted Rapid Palatal Expansion (SARPE) as treatment options for maxillary transverse deficiencies in adults and adolescents using methods such as cohort studies, case-control studies, reviews, and retrospective studies. Researchers must assess the effects of treatment, taking into account skeletal and dental alterations as well as stability and relapse indicators. The kinds of studies that were included were not restricted, but they had to fulfill the following requirements: published in full-text English, and peer-reviewed journals. Research with inadequate data, unclear procedures, case reports, reviews, editorials, and/or commentaries, as well as research that primarily focuses on other types of expansion techniques, were omitted based on exclusion criteria. Additionally excluded were animal trials, studies conducted in flasks and test tubes, and duplicate publications involving the same individuals.

### Data extraction

To improve coherence, two researchers used a data extraction form to perform the data extraction. The basic outcomes, such as the skeletal and dental alterations, the relapse rate, treatment stability, and follow-up time, were assessed following the customs of each task. Details about any complications or unfavourable incidents were also noted. The writers' disputes were discussed, and a third author was consulted as necessary. After being extracted from the publications, the raw data was organized into a database that facilitated comparisons between the results of various investigations.

### Ethical consideration

This paper based on the available literature hence did not need any ethical approval to be conducted. No new data were collected including human participants. All the articles reviewed in this study were accessed from open-access sources, and all required citations were made in compliance with the ethical principles governing research studies. This approach was useful in as much as it eliminated any issues of ethical clearance while at the same time being detailed in an objective approach to the research.

## RESULTS

### Clinical effectiveness of MARPE and SARPE in correcting maxillary transverse discrepancies

Clinical effectiveness has been established for the techniques utilized to repair the maxillary transverse: Microimplant-Assisted Rapid Palatal Expansion (MARPE) and Surgically Assisted Rapid Palatal Expansion (SARPE). While MARPE is linked to

larger gains in terms of the dental and alveolar process (Chun et al., 2022), MARPE is said to be able to safely apply greater skeletal expansion than SARPE, particularly in terms of midfacial width, nasal floor area, and both the anterior and posterior palatal width (Oliveira et al., 2021). The rate of skeletal expansion is nearly evenly distributed throughout the upper midface and a larger portion of the front palate, as is shown by MARPE therapy. However, SARPE may leave a triangular-shaped aperture, with the anterior portion having a significantly larger opening and the top of the triangle inside the nasal cavity (Santarsiero et al., 2021).

The MARPE treatment has better skeletal benefits than SARPE because MARPE leads to skeletal expansion, including widening the mid-palatal suture, nasal width, and jugular width, with a significant skeletal expansion percentage (55.76%). (Siddhisaributr et al., 2022). This is crucial, particularly in situations requiring orthopaedic treatment, like Class III malocclusion, which lowers resistance to maxillary protraction when facemask therapy is used (Moon et al., 2018). By supporting the expansion screw with a mini-screw, the MARPE appliance opens the mid-palatal suture more evenly and precisely than the traditional RPE (Rapid Palatal Expansion) (Paneriya et al., 2021). The midpalatal suture separates as a result of the expansion force that these mini-screws immediately drive into the palate (Kapetanovic et al., 2022). The force produced appears to have an impact on the zygomatic bones as a component of the midfacial complex due to the cephalad-translated vector force of the appliance used in the MARPE procedure (Hoque et al., 2021). This force application damages the mid-palatal suture and results in a main biological reaction (Singh et al., n.d). The MARPE is an effective non-surgical treatment for maxillary insufficiency in adult patients by improving the skeletal consequences of maxillary expansion. The increased extension of the midfacial region, which includes the zygomatic bones, is one of the main advantages of MARPE therapy. This allows for a wider viewpoint, which can improve the correction of the maxillary deficit (Hoque et al., 2021; Papalkar et al., 2022). MARPE helps to improve vertical control and lessen dental tilting (Allam et al., 2024).

According to recent systematic review and meta-analysis, the mean skeletal and dental transverse expansion was higher in the patients. The mean alveolar bone, mean dental expansion, and basal bone composition made up 48.85%, 7.52%, and 43.63% of the overall expansion, respectively. Over time, there was a certain amount of skeletal and dental recurrence. MARPE may also affect the soft tissues of the face, upper airway, and other craniofacial bones in addition to causing dental, alveolar, and periodontal side effects (Zeng et al., 2023).

Patients who are unable to have operations like the surgically aided rapid palatal expansion (SARPE) for the adult maxillary deficit are advised to have it done (de Melo Quintela et al., 2021). In patients with fused maxillary sutures, the use of mini-screws in MARPE can reduce the invasiveness of therapy and improve the predictability of treatment results (Viet et al., 2024). Due to its extensive dental tilting and minimal vertical skeletal alteration, which can create a V-shaped opening, SARPE offers both significant benefits and drawbacks despite its widespread use in dentistry (Hudson et al., 2021). By performing osteotomies with distraction osteogenesis in the maxillary arch, SARPE enhances palatal distraction (Calvo-Henriquez et al., 2020). Adults with dysgraphia may have the surgery as the initial surgical step in their orthodontic treatment (Rachmiel et al., 2020).

After an adult patient's growth has stopped, SARPE has been shown to be both biomechanically and clinically successful and rigid enough to address transverse insufficiency in the maxilla. The maxillary first molar's maximum expansion, when stopped, is  $7.60 \text{ mm} \pm 1.57 \text{ mm}$  on average, and the relapse is 1.83 mm (Chamberlandet al., 2011). Among the many benefits of SARPE are the following: Space creator for transverse maxillary deficit treatment, Arch enlargement for greater, decrease in anterior crowding, The smile's appearance (Instituto Maxilofacial., 2019). Hence, Adult dysgraphia and transverse maxillary deficit can be effectively treated with SARPE, an effective surgical orthodontic method. Otherwise, it describes orthodontic treatment combined with oral and facial surgery, namely on the maxilla, to correct the position of the maxillary arch both aesthetically and functionally. SARPE is less effective than MARPE in the case of nasal cavity expansion (Bastos et al., 2024), but it offers good results for adult patients, particularly regarding the width of the upper airway (Krishnan et al., 2022). In comparison to SARPE, which focuses primarily on alveolar and dental expansion with significantly more dental tipping, the combined results show that MARPE exhibits greater clinical efficiency concerning skeletal expansion, preferentially concentrated in the nasal and midfacial areas (de Oliveira et al., 2021).

### **The stability of the results for MARPE and SARPE**

According to the qualitative analysis, most trials had low relapse rates after more than a year of expansion, indicating the stability of treatment outcomes. MARPE may also be a useful therapy option for MTD patients. In late adolescence, it causes a significant enlargement of the transverse skeleton. The current study also found that MARPE has some therapeutic advantages and that its negative effects on periodontal tissues are negligible in comparison to traditional RPE (Huang et al., 2022). Evidence of a negative correlation between age and MARPE success rate was discovered in another investigation. In 15–19, 20–29, and 30–37 years, respectively, MARPE's failure rate was 83.3% (Oliveira et al. 2021). The success rate in the Choi et al. trial was, but according to the Choi et al. investigation, the success rate was 86.96%. Thus, osteotomy of the midpalate

suture failed in 9 out of 69 patients with MTD (Choi et al., 2018). With a high success rate and some degree of skeletal and dental regression over time, MARPE has been shown to be an effective treatment for transverse maxillary insufficiency. Transverse maxillary deficit can be effectively treated with MARPE (mean success rate: 93.87%). The mean skeletal and dental transverse expansion was higher in the patients. The mean alveolar bone, mean dental expansion, and basal bone composition made up 48.85%, 7.52%, and 43.63% of the overall expansion, respectively. Over time, there was a certain amount of skeletal and dental recurrence. MARPE may also affect the soft tissues of the face, upper airway, and other craniofacial bones in addition to causing dental, alveolar, and periodontal side effects (Zeng et al., 2023).

At the bone and dental levels, SARPE causes a significant rise that appears to be constant. Small but persistent skeletal alterations were observed with SARPE, and dental relapse was attributed to posterior expansion at the tongue, which is caused by the lingual migration of the posterior teeth. There was a noticeable backward shift in dental expansion, indicating that nearly all relapses were caused by posterior teeth moving lingually; 64% of the patients exhibited dental changes larger than 2 mm. Dental recurrence in phase 2 surgery was unaffected by FLP (Gogna et al., 2020; Chamberland et al., 2011).

When compared to SARPE, the MARPE produced noticeably more skeletal transverse maxillary expansion at the palate and basal bone, primarily in the posterior region. Another study showed that, compared to SARPE, more skeletal transverse maxillary expansion took place at the midface and basal bone while using MARPE, especially at the posterior region.

Lastly, it is important to highlight that while MARPE's long-term stability has not yet been verified, both SARPE and MARPE have shown an increase in stability. Although there is a slight relapse in dental expansion, SARPE has also been observed to result in persistent modifications in the suture between the maxilla and the premaxilla. Future research is required to gain a better understanding of the general stability and repeatability of such processes (de Oliveira et al., 2021).

### **Potential issues and consequences associated with MARPE and SARPE**

According to an observational study specifically focused on possible side effects of MARPE, with a respectable success rate of 88.88% in the separation of the mid-palatal suture out of 27 patients, it is also clear that Mini screw-assisted rapid palatal expansion (MARPE) is effective in both dentoalveolar and skeletal expansion. Nevertheless, there are a number of drawbacks and repercussions to the process. Among the complications noted were the patient's excessive buccal tilting of the canine, alterations in the occlusal planes in 37% of cases, and a notable decrease in buccal bone height at the first molar in only 40.7% of cases. However, 22.22% of the patients exhibited proven hypertrophy of the palate mucosa, accompanied by symptoms of pain, erythema, ulcerations, and itching. Complacency with mucosal ischaemia, infections, and treatment failure because of ossification or interdigitalization at the mid-palatal suture were observed, despite the absence of palatal mucosa necrosis. The mean increase at the mid-palatal suture was also readily perceptible. Overall, the evidence presented in our MARPE case series supports the predictable use of MARPE to correct transverse maxillary deficiencies. Nevertheless, the technique does present soft tissue and dentoalveolar changes that require effective patient selection and management plans to prevent or minimise these complications (Bud et al., 2021).

The SARPE study indicates that there are a number of drawbacks and repercussions associated with the operation. To the astonishment of the authors, the overall rate of problems in this study was 52.25% in 111 patients. Neurosensory abnormalities were the most common complications, occurring in 27.03 percent of patients and post-operative pain in 13.51% of patients. Additionally, NSDs were noticeably prolonged; 21.62% of patients experienced these disruptions for longer than four weeks, and some of them continued for more than a year. This component was linked to the mean age of patients with dental issues or the development of oral disorders (Smeets et al., 2020). Postoperative severe bleeding, oro-nasal communication, palatal ulceration, uneven maxillary growth, and occasionally non-union of the bone were among the other problems noted (da Costa Senior et al., 2021). According to the study, a patient's age has a substantial impact on the likelihood of difficulties. This suggests that older patients are more likely to experience long-term problems, which supports the idea that it is important to find the right patient for treatment, particularly for senior people. Additionally, several need extended hospital stays due to nausea, vomiting, or monitoring following surgery (Smeets et al., 2020). Overall, the treatment of maxillary transverse deficits may be enhanced by SARPE; however, the risk and complication profile should indicate careful preoperative counselling and patient demographic considerations.

SARPE complication was experienced in 9.73% cases (Nowak et al., 2024). Several early complications that include palatal mucosa necrosis, the perforation of maxillary alveolar process, and asymmetric distraction may still discomfort the patient and may need intervention (Olszewski et al., 2019). The delayed effects are ankylosis and root resorption of maxillary incisors together with necrosis that may predispose patients to future dental problems and extra expenses (Krishnan et al., 2022). Even while closely related complications lengthen treatment, increase patient stress, and lower satisfaction rates, these

issues can be generally classified as minor and rarely change the outcome. Therefore, to lower these risks and enhance patients' overall care, appropriate patient screening and technique-sensitive surgical methods must be used (Nowak et al., 2024).

## DISCUSSION

The clinical efficacy of Micro Implant-Assisted Rapid Palatal Expansion (MARPE) and Surgically Assisted Rapid Palatal Expansion (SARPE) in resolving maxillary transverse discrepancies is confirmed by this thorough study. Even though the phases in each procedure are quite successful at correcting maxillary defects, their levels of success vary. According to the research, MARPE can improve skeletal compliance more than SARPE, especially when it comes to MP width and anterior and posterior palatal width (Oliveira et al., 2021). This is consistent with Hernández-Alfaro and Valls-Ontañón's statement regarding the importance of using CBCT to assess the midpalate suture maturity prior to therapy in order to choose the best course of action (Hernández-Alfaro and Valls-Ontañón's, 2021).

Increased mid-palatal suture and better nasal and jugular dimensions are among the skeletal benefits of MARPE, making him a better option for patients in need of orthopaedic correction, such as Class III malocclusion (Siddhisaributr et al., 2022). However, because force is delivered using mini-screws, the MARPE approach has been found to provide for a more exact and balanced gap in the mid-palatal suture (Paneriya et al., 2021). This approach deviates from SARPE, which could result in an uncontrolled expansion and subsequent orthodontic procedures due to the aperture's triangular form (Santarsiero et al., 2021).

Furthermore, there appears to be an improvement in the results provided by MARPE, despite the fact that both approaches have some degree of skeletal and dental (anchor) relapse over time. In addition to the fact that only a small number of the listed studies reported low relapse rates, this new data shows that the mean success rate of MARPE therapy in patients with transverse maxillary deficiencies can reach 93.87 percent (Choi et al., 2018; Zeng et al., 2023). This is consistent with the qualitative analysis in this article, which found that MARPE had few adverse effects and therapeutic benefits in periodontal tissue (Huang et al., 2022).

In contrast to the benefits of SARPE, this technique has been described as involving complications and some limitations in the senior patient. Although SARPE is a reliable surgical procedure, it has been associated with conspicuous dental tilting and V-shaped opening of the maxilla which should be taken into consideration (Hudson et al., 2021). Surgical malocurrences presented with SARPE range from neurosensory disturbances to postoperative pain and therefore stress the importance of surveillance before the surgical procedure and counselling (Smeets et al., 2020). Some research shows that SARPE complication rate may range up to 52.25%, which is why patient selection should be carried out carefully (da Costa Senior et al., 2021).

Additionally, these methods affect soft tissue and craniofacial morphology in addition to bone structures, which may improve facial aesthetics, upper airway patency, or both. However, the marginally higher prevalence of complications in SARPE patients as opposed to MARPE patients may suggest that MARPE is a safer and more successful non-surgical treatment option for individuals with periodontal disease, particularly for those who are unable to have general surgery (Krishnan et al., 2022).

The study includes the following limitations: First, the information in this document was derived from published publications, which may have resulted in implicit bias because unfavourable findings are usually underreported. Second, few studies offer patient follow-up of more than five years, making assessing the duration of therapy efficacy and relapse incidence difficult. Finally, changes in intervention application and dosage, patient characteristics, and practitioner style between studies may introduce confounding factors into the research that are not adequately controlled.

## CONCLUSION

About the selection of dento-facial instruments the effectiveness of MARPE and SARPE in treating maxillary transverse discrepancies was noted in this study on committees on rules applicability and two treatment modern procedures. MARPE is the recommended nonsurgical orthognathic surgery procedure because it demonstrates improved skeletal cheekbone progress and stability, especially in adult patients. Conversely, despite its efficiency, SARPE has a much higher rate of complications and a smaller degree of bone contouring. However, patient outcomes can be enhanced by considering the use of both irradiation and resection in the context of patient management and selection. Thus, greater research on the durability of these methods and their potential to improve patient outcomes should be conducted in the future.

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