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# COMPARATIVE OUTCOMES OF SURGICAL AND NON-SURGICAL APPROACHES IN MAXILLARY TRANSVERSE DEFICIENCY TREATMENT

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## ABSTRACT

**Aim of the study** Maxillary transverse deficiency (MTD) significantly impacts oral function, facial aesthetics, and respiratory health. Treatment modalities range from non-invasive skeletal expansion techniques to complex orthognathic surgery. This study aimed to compare the clinical effectiveness of three distinct approaches—Maxillary Skeletal Expander (MSE), Surgically Assisted Rapid Palatal Expansion (SARPE), and segmented Le Fort I osteotomy (LFT)—in adult patients diagnosed with MTD. The null hypothesis was that no significant difference exists between these treatment strategies. **Materials and methods** A total of 30 adult patients diagnosed with MTD were allocated into three treatment groups (MSE, SRP, and LFT). Pre- and post-treatment evaluations included clinical examination, cone-beam computed tomography (CBCT), and psychological assessment. Primary outcome measures were interpremolar distance, distance between palatal root apices of molars, and nasal airway volume. Data were analyzed using one-way ANOVA and Tukey post-hoc tests at a significance level of $p < 0.05$. **Results** Statistically significant increases in interpremolar width, root apex distance, and nasal airway volume were observed in all groups post-treatment ($p < 0.001$). The LFT group showed the highest skeletal and airway improvements, followed closely by the SRP group. The MSE technique yielded more limited changes, primarily within the alveolar process. Patient-reported discomfort was lowest in the MSE group and highest in the LFT group. **Conclusions** All three techniques improved transverse maxillary dimensions, but their effectiveness varied with case severity. LFT remains the most effective for severe cases, while SRP and MSE are appropriate for moderate and mild forms, respectively. Individualized treatment planning, combined with long-term retention strategies, is critical for sustained outcomes.

## INTRODUCTION

Dento-maxillary abnormalities can significantly affect quality of life, as greater severity is often associated with increased functional limitations and psychosocial distress, regardless of patient age [1]. These conditions impair essential oral functions and hinder social participation, thereby impacting overall health and psychological well-being. An important feature of these dysfunctions is the transverse maxillary dimension, which is frequently altered in malocclusions [2]. Such alterations are prevalent in Class II cases (characterized by maxillary compression syndrome with tooth protrusion, spacing, or crowding), as well as in Class III malocclusions and facial asymmetries [1].

Orthodontic treatment is the primary therapeutic approach, while severe cases require orthognathic surgery to reposition the viscerocranial bone structures, thereby restoring dentofacial balance and improving quality of life [3]. Clinical and imaging methods play a critical role in evaluating maxillary transverse deficiencies, revealing a significant prevalence of skeletal anomalies among patients undergoing orthognathic procedures [4]. A decreased maxillary width adversely affects facial aesthetics as well as functional processes such as mastication, deglutition, and respiration. Individuals diagnosed with maxillary compression syndrome commonly present with impaired chewing function and a heightened risk of



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developing bronchopulmonary complications, as evidenced in clinical observations [3,4].

Treatment planning relies on advanced imaging modalities, particularly three-dimensional cone beam computed tomography (CBCT), which provides a comprehensive view of skeletal changes and associated complications. Radiographic evaluation facilitates the identification of growth imbalances and maxillomandibular discrepancies, thereby optimizing treatment strategies [4]. Maxillary transverse deficiency has also been shown to compromise respiratory function by narrowing the nasal airway and influencing the positioning of the hyoid bone and tongue. Surgical correction of these deficiencies has been shown to significantly improve respiratory function, emphasizing the need for an integrated orthodontic-surgical approach [5].

Technological advances and greater accessibility to modern diagnostic tools have heightened patient interest in orthodontic-surgical treatments. The prevalence of orthognathic surgery is rising; however, many patients continue to pursue orthodontic approaches aimed at concealing underlying skeletal discrepancies [6]. The "surgery first" concept has revolutionized treatment protocols by eliminating the need for a preoperative orthodontic phase, thereby accelerating skeletal correction [7].

Early intervention is essential to correct muscular, skeletal and dental imbalances. The targeted use of orthodontic appliances during the growth phase, followed by fixed orthodontic treatment, can minimize the need for more invasive surgical interventions [8]. In severe cases, treatment options include mandibular growth stimulation or advanced orthognathic procedures such as the Le Fort I osteotomy [9]. In this regard, surgically assisted rapid palatal expansion (SARPE) is a minimally invasive and highly effective technique for correcting transverse discrepancies. The correction of maxillary transverse discrepancies plays a central role in the treatment of Class II and III malocclusions. Successful treatment requires a multidisciplinary approach to ensure individualized care and optimal patient outcomes [10].

The aim of this study was to compare the effectiveness of the conventional orthodontic approach with the surgery-first technique in the treatment of maxillary transverse deficiencies. The null hypothesis stated that no significant difference exists between these treatment strategies.

## MATHERIALS AND METHODS

*2.1. Selection of subjects. Inclusion criteria.*

This study included a cohort of 30 participants, selected from patients treated at the Paediatric Dentistry Clinic and the Maxillofacial Surgery Clinic in Iași between 2020 and 2024. The required sample size was determined using the G*Power software, based on an alpha level of 0.5, a statistical power of 0.8, and an effect size of 0.6, which indicated a minimum recommended sample size of 30 subjects. Participants were allocated into three study groups according to the treatment option: the *MSE group* underwent surgically assisted orthodontic treatment involving mini-implant-supported rapid maxillary expansion; the *SRP group* received a minimally invasive protocol for surgically assisted rapid palatal expansion (SARPE); and the *LFT group* was treated using a segmented Le Fort I osteotomy for maxillary expansion.

To be included in this study, participants had to meet the following inclusion criteria:

Age over 18 years; patients diagnosed with a transverse dento-maxillary anomaly with an indication for surgical-orthodontic treatment,


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established after orthodontic and surgical examination at the County Emergency Hospital "St. Spiridon", Iasi.

*2.2. Preoperative assessment*

The working protocol commenced with a comprehensive preoperative assessment comprising orthodontic, surgical, and psychological evaluations.

The orthodontic evaluation included a detailed clinical examination, extraoral and intraoral photography, dental arch impressions, fabrication of maxillary and mandibular study models, lateral cephalometric radiography, and cone-beam computed tomography (CBCT) of both jaws. This was followed by skeletal, dental, and occlusal analysis to establish a diagnosis and outline appropriate therapeutic strategies.

The surgical evaluation involved clinical assessment, review of orthodontic documentation, preparation and articulation of plaster study casts, simulation of skeletal movements, determination of optimal maxillomandibular relationships, and evaluation of occlusal stability. Additionally, occlusal splints were fabricated. The patient's general health status was assessed through laboratory investigations, including complete blood count, biochemical parameters (glucose, cholesterol, triglycerides, total protein, ionogram, renal function: urea, creatinine, uric acid; liver function: ALT, AST, total and direct bilirubin), coagulation profile (INR, PT, aPTT), and cardiovascular assessment (blood pressure, heart rate, and electrocardiogram).

The psychological assessment addressed the psychosocial aspects relevant to the study by evaluating the patient's level of psychological comfort, self-esteem, and perceived quality of life.

*2.3. Therapeutic procedures*

Based on the clinical context, therapeutic indications, and patient compliance, various treatment modalities were employed, including orthodontic approaches (slow or rapid maxillary expansion), surgically assisted orthodontic techniques (surgically assisted rapid maxillary expansion or mini-implant-assisted rapid maxillary expansion), and surgical interventions (segmented Le Fort I osteotomy for maxillary expansion).

Patients in the MSE (Maxillary Skeletal Expander) group underwent paraclinical assessment, which included orthopantomography, frontal and lateral cephalometric radiographs, and cephalometric analysis according to Steiner's method.

The osteodistraction technique was used to correct maxillary anomalies through the use of a Maxillary Skeletal Expander (MSE) supported by mini-implants. The expander was positioned at the molar–premolar level, with its body placed as close as possible to the palatal mucosa to ensure effective transmission of forces to the underlying bone. Mini-implants were inserted bilaterally along the midpalatal suture in regions with adequate bone volume and density. Cone-beam computed tomography (CBCT) imaging was used to assess the interpremolar distance and the distance between the dental apex and the palatal root of the supporting molar.

Patients in the SRP group underwent correction of dentomaxillary anomalies using a minimally invasive technique for surgically assisted rapid palatal expansion (SARPE) [11], performed under intravenous sedation. Following the SARPE procedure, the effectiveness of maxillary osteodistraction was assessed using CBCT two months after the expansion phase. CBCT imaging was analyzed to evaluate the appearance of the osteotomy lines.

At the end of treatment, patients underwent both clinical and paraclinical reassessments. New measurements were taken to evaluate the


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interpremolar distance and the distance between the dental apex and the palatal root of the supporting molars. The airway volume at the level of the nasal floor was assessed using defined anatomical landmarks.

In the LFT group, the correction of dentomaxillary anomalies involved a comprehensive surgical approach, including anterior maxillary exposure, dissection and identification of the nasal fossa, pyriform apertures, and nasal septum, followed by a Le Fort I osteotomy [12]. This was accompanied by a mid-sagittal osteotomy, pterygomaxillary disjunction, mobilization of the maxilla, and evaluation of the effectiveness of the disjunction device. The procedure completed with the readaptation of the surgical site and suturing of the soft tissues.

Following surgical intervention, the disjunction device was activated to achieve lateral arch expansion, facilitate soft tissue adaptation to maxillary repositioning, and accomplish overall maxillary widening. A follow-up CBCT assessment was conducted two months postoperatively to evaluate changes in bone density.

*2.4. Postoperative evaluation*

Surgical Evaluation: Postoperative orthopantomograms were performed to verify skeletal proportions and confirm the accurate placement of osteosynthesis plates and screws. Elastic intermaxillary fixation devices were applied to stabilize the maxillary and mandibular bases in their newly established positions.

Orthodontic Assessment: The integrity and functionality of the fixed orthodontic appliances used for dental movement and initiation of treatment were examined.

Psychological Evaluation: Standardized psychological assessments were conducted using validated questionnaires, administered at one month and again at one year postoperatively.

These procedures represent essential components of the standard surgical protocol and routine postoperative follow-up. To assess the treatment outcomes, postoperative measurements of the interpremolar distance and the distance between the apexes of the palatal roots of the molars were analyzed.

*2.5. Statistical analysis*

The data were analyzed with SPSS 29.0.0, using the one-way ANOVA test to determine differences between preoperative and postoperative values, and the Tukey post-hoc test to evaluate specific differences between groups. The statistical analysis was performed using a significance level of $p = 0.05$.

**RESULTS AND DISCUSSIONS**

Statistical analysis revealed significant post-treatment changes in all three groups (MSE, SRP, and LFT) regarding interpremolar distance, the distance between the palatal root apices of the first molars, and nasal airway volume (Table 1). One-way ANOVA indicated that the magnitude of these changes differed significantly between groups for all measured parameters. Figure 1 illustrates the mean changes and standard deviations for all evaluated parameters, confirming the trends observed in the statistical analysis.


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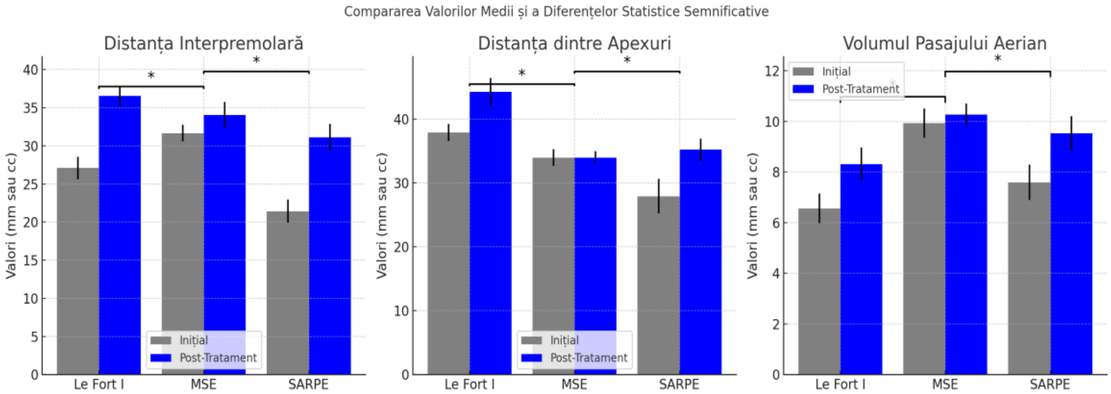
*Table 1. Baseline and post-treatment values of the evaluated parameters (mean ± SD), along with the mean differences (Δd) and p-values from one-way ANOVA.*

| | MSE Group | | | SRP Group | | | LFT Group | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Evaluated parameter | Initial value (mm) | Value after treatment (mm) | *Δd* | Initial value (mm) | Initial value (mm) | *Δd* | Value after treatment (mm) | Value after treatment (mm) | *Δd* | *p* |
| PM1 PM1 interpremolar distance | 31,19 | 34,57 | 3,38 | 22,99 | 31,60 | 8,61 | 27,51 | 36,2 | 8,69 | *<0.001* |
| PM2 PM2 Interpolar distance | 36,42 | 38,26 | 1,84 | 27,34 | 35,54 | 8,2 | 32,89 | 42,2 | 9,31 | *<0.001* |
| Distance between the apexes of the palatinal molar root apices | 33,96 | 34,14 | 0,18 | 27,97 | 35,28 | 7,31 | 37,71 | 44,03 | 6,32 | *<0.001* |
| Nasal air passage volume (cc) | 9,93 | 10,17 | 0,24 | 7,86 | 9,27 | 1,41 | 6,64 | 8,08 | 1,44 | 0.0013 |

Figure 1. Mean values and standard deviations of interpremolar distance, root apex distance and airway volume before and after treatment for each group analyzed (*MSE, SRP, LFT*).




For the interpremolar distance, the ANOVA test yielded a value of F = 50.06 with p < 0.0001, indicating a statistically significant difference among the three groups. This finding suggests that the treatment methods had varying effects on interpremolar width. Post-hoc Tukey analysis revealed that both the SRP and LFT groups achieved significantly greater transverse expansion compared to the MSE group in terms of interpremolar and intermolar distances (p < 0.05). Although both surgical groups demonstrated similar expansions, the LFT group exhibited a slightly greater gain, particularly in skeletal parameters.

For the distance between the palatal root apices, the ANOVA result was F = 21.21 with p < 0.0001, also demonstrating a significant effect of the interventions on root positioning. Minimal change was noted in the MSE group (Δd = 0.18 mm), indicating limited skeletal displacement. In contrast, SRP and LFT groups showed significant widening (Δd = 7.31 mm and 6.32 mm, respectively), consistent with osteogenic maxillary expansion.

Regarding the nasal airway volume, the ANOVA analysis produced an F-value of 8.60 with p = 0.0013, indicating a statistically significant difference, although less marked compared to the other two variables. The LFT and SRP groups demonstrated a statistically significant increase (Δd = 1.44 $cm^3$ and 1.41 $cm^3$, respectively), suggesting improved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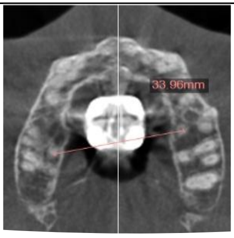
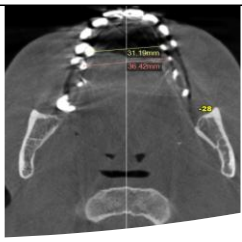
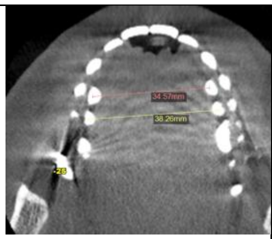
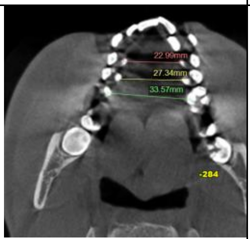
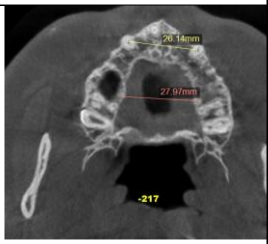
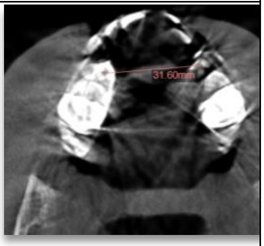
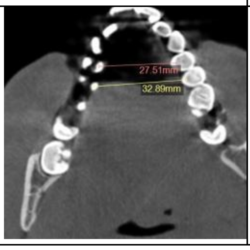
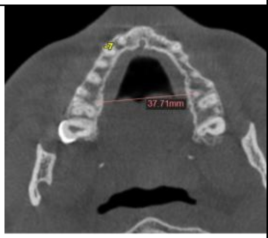
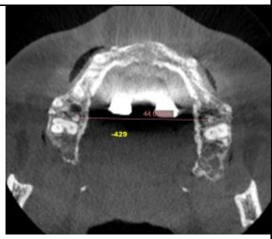
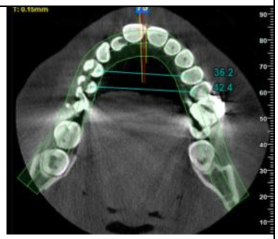
respiratory function. The MSE group showed only a modest volume increase (Δd = 0.24 cm³), which did not reach clinical relevance.

Table 2. Representative CBCT images illustrating maxillary expansion before and after treatment for each technique, including measurement methodology.

| Group | Pre-tratment masurements | | Post-tratment masurements | |
|---|---|---|---|---|
| MSE |  |  |  |  |
| SRP |  |  |  |  |
| LFT |  |  |  |  |

In Table 2 are presented representative CBCT images illustrating the maxillary expansion achieved through the various treatment techniques. These images offer a visual comparison of pre- and post-treatment measurements, emphasizing structural changes within the maxillary arch. The table also provides a detailed description of the measurement methodology, ensuring precision and consistency in the evaluation of each treatment's effectiveness. The CBCT scans highlight key anatomical landmarks, enabling comprehensive assessment of changes in maxillary width, dental root positioning, and nasal airway volume resulting from both orthodontic and surgical interventions.

The findings of this study corroborated previously reported trends in the literature regarding the effectiveness of techniques used for transverse maxillary expansion. When compared with the data presented by [13], the results indicated that the Maxillary Skeletal Expander technique produced a moderate degree of transverse expansion, with changes primarily localized to the alveolar process and minimal alterations observed in the skeletal structures. These outcomes supported the clinical use of the MSE method in the treatment of mild to moderate cases [14].

Furthermore, another study showed that skeletal anchorage using mini-implants contributed to a reduction in adverse effects on the supporting teeth [15]—an observation also supported by the present study, which demonstrated less root displacement in comparison to surgical methods.

A comparative analysis of the three maxillary transverse expansion techniques revealed significant differences in the magnitude of their effects. While the MSE technique resulted in moderate changes, the SARPE method produced a more substantial expansion, with a significant increase in interpremolar distances, consistent with the findings reported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by [16]. These results highlighted the importance of selecting the appropriate treatment option based on the severity of maxillary constriction and the individual characteristics of each patient.

The findings of the present study were consistent with those reported by [17], who demonstrated the efficacy of surgically assisted rapid palatal expansion (SARPE) in adult patients with fused midpalatal sutures. The significant postoperative increases observed in interpremolar and interradicular widths, as quantified through cone-beam computed tomography (CBCT) analysis, aligned with the results of another study [16], further corroborating the stability and uniformity of maxillary expansion achieved through SARPE. Notably, these outcomes were obtained without compromising the integrity of the dentoperiodontal structures, underscoring the technique's clinical reliability and biological safety.

An advantage of the SARPE technique lay in its positive impact on nasal airway volume, thereby contributing to enhanced respiratory function. This benefit was substantiated by Zaoui et al. [18], who identified SARPE, along with Le Fort I osteotomy, as the most effective interventions in promoting airway enlargement. In contrast, the midfacial skeletal expander demonstrated a comparatively limited influence on this parameter [18,19]. These findings suggested that while MSE was effective in achieving transverse skeletal expansion, its role in improving airway patency—particularly in individuals with obstructive sleep apnea—may have required adjunctive procedures to attain optimal outcomes.

The Le Fort I segmental osteotomy was shown to have the most significant effect on the skeletal structure of the maxilla [20]. According to Nemoto et al., this technique allowed for a wider and more stable transverse expansion than minimally invasive methods [21]. The current data supported these findings, showing that the Le Fort I osteotomy resulted in significant increases in interpremolar and interradicular distances, as well as a significant improvement in nasal airway volume. Studies conducted by Joseph et al., highlighted the superiority of this technique in terms of skeletal changes, confirming our observations of its effectiveness in severe cases of maxillary transverse deficiency [22].

The observed increase in nasal airway volume, particularly following SARPE and Le Fort I osteotomy, may have significant implications for the management of obstructive sleep apnea (OSA) [23]. Maxillary expansion facilitates improved nasal airflow and reduces pharyngeal airway resistance, contributing to enhanced upper airway patency. These anatomical changes are especially relevant in patients with preexisting nasopharyngeal constriction. Accordingly, volumetric assessment of the upper airway via CBCT should be considered a valuable functional parameter in treatment planning, particularly in cases where respiratory compromise is suspected [23,24].

The comparison of the three analyzed methods suggested that the choice of therapeutic approach should have been guided by individual patient characteristics. According to other studies, factors such as the patient's age, the degree of suture fusion, and the desired effect on adjacent structures played a crucial role in determining the therapeutic plan [22,25]. The data from this study confirmed that MSE was a viable option for younger patients, SARPE offered significant benefit in adults, and the Le Fort I osteotomy remained the gold standard for severe cases of maxillary compression.

An important aspect to consider was the stability of long-term results. Studies performed by El Aouame et al. and Matsumoto et al. suggested that maxillary expansion achieved by minimally invasive methods, such as MSE and SARPE, had a higher risk of postoperative relapse without adequate orthodontic maintenance [26,27]. Our data supported this hypothesis, showing higher cross-sectional variations in patients treated with MSE compared to those who underwent Le Fort I osteotomy. Although the latter provided more stable results, it was associated with a longer recovery and more complex management of patient discomfort, as also highlighted by Zeng et al. [28]. These findings highlighted the importance of individualized planning and an effective postoperative strategy to maintain long-term results. In this regard, longitudinal studies were needed to investigate additional methods of retention and factors influencing recurrence to help optimize therapeutic strategies.

Transverse maxillary expansion had implications not only for occlusion and facial


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aesthetics, but also for respiratory function. A study showed that surgical widening of the maxillary arch could increase nasal airway volume, thereby reducing the risk of OSA [29]. The current data confirmed this hypothesis, particularly in the SARPE and Le Fort I osteotomy groups, where the improvement in airway volume was significant.

The patient's perception of postoperative discomfort was another important factor in choosing the optimal method. According to the study by [28], patients treated with SARPE reported a higher degree of postoperative discomfort than those treated with MSE, but significantly less than those treated with Le Fort I osteotomy. The data from this study confirmed this observation and emphasized that although Le Fort I osteotomy was the most effective method of jaw expansion, it required a longer recovery period and careful postoperative pain management.

While this study provided valuable insights into the immediate skeletal and functional changes following different expansion techniques, long-term stability remained a critical factor in determining treatment success. Previous studies suggested that minimally invasive methods like MSE and SARPE may have exhibited higher relapse rates without proper retention protocols [29,30]. This emphasized the importance of post-treatment maintenance strategies, including the prolonged use of retainers and follow-up evaluations with CBCT to monitor skeletal remodeling over time. Additionally, a longitudinal approach extending follow-up to at least 3–5 years would have provided more definitive conclusions regarding the durability of maxillary expansion and the potential for late-stage relapse.

However, there were some limitations to this study. First, the sample size was relatively small, which may have affected the generalizability of the results. Second, the duration of postoperative follow-up was limited, which did not allow a full assessment of the long-term stability of each method. In addition, individual variability in biological response to treatment and patient compliance with retainer wear may have influenced the final results. Although the sample size was calculated using G*Power with appropriate statistical parameters, the relatively small number of participants (n =

4. .

30) may have limited the generalizability of the findings. Moreover, inter-individual biological variations could also influence the therapeutic response of patients. Future studies with larger cohorts were necessary to validate these results and assess long-term stability.

Therefore, this study confirmed the trends highlighted in the literature and emphasized the need for a personalized approach to the treatment of maxillary transverse deficiency. The integration of advanced imaging technologies, such as CBCT, allowed a detailed assessment of skeletal changes and facilitated evidence-based therapeutic decisions. Future research should investigate the long-term effects of each method and develop optimal retention strategies to minimize the risk of recurrence.

## CONCLUSIONS

1. This study demonstrated that the extent and stability of transverse maxillary expansion differ significantly across treatment modalities. The Le Fort I osteotomy achieved the most substantial and predictable skeletal changes, making it the optimal choice for severe maxillary constriction, particularly when functional improvements, such as increased nasal airway volume, are also desired.
2. SARPE technique proved to be a highly effective and less invasive alternative, yielding significant transverse gains and improvements in airway patency in adult patients. In contrast, the MSE technique, while offering minimal invasiveness and favorable patient comfort, resulted in limited skeletal expansion and is better suited for mild to moderate cases.
3. Treatment decisions should be individualized based on patient age, skeletal maturity, clinical severity, and airway considerations. CBCT imaging plays a crucial role in diagnosis and follow-up, enabling precise evaluation of skeletal changes. Future research should focus on long-term stability, retention strategies, and the functional implications of expansion techniques, particularly in relation to airway health.


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