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RETENTION AND POST EXPANSION STABILITY AFTER MARPE : A SYSTEMATIC REVIEW

Dr. Rishabh Goswami[1], Dr. Bhagyashree Desai[2], Dr. Aakash Shah[3], Dr. Neel Shah[4], Dr. Manisha Tripathi[5], Dr. Anupa Dave[6], Dr. Vrunda Shah[7]

[1]Post Graduate Student. Department of Orthodontics and Dentofacial Orthopedics, Faculty of Dental Science, Dharmsinh Desai University. India. Email: rishabhize@gmail.com; Orcid id: 0009-0001-1535-5184
[2]Lecturer, AMC Dental College and Hospital Email: bhagyashree1@live.com; Orcid id: 0000-0003-3492-9697
[3]Professor and Head of the Department, Department of Orthodontics and Dentofacial Orthopedics, Faculty of Dental Science, Dharmsinh Desai University. India. Email: aakash1172@gmail.com; Orcid id: 0009-0001-1148-2426
[4]Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Faculty of Dental Science, Dharmsinh Desai University. India. Email: nilshah5555@gmail.com; Orcid id: 0009-0005-0805-1448
[5]Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Faculty of Dental Science, Dharmsinh Desai University, Nadiad. India. Email: tripathimanishaortho672@gmail.com; Orcid id : 0009-0003-6546-9347
[6]Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Faculty of Dental Science, Dharmsinh Desai University. India. Email: anupa.dave@yahoo.in; Orcid id: 0009-0008-1555-0212
[7]Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Faculty of Dental Science, Dharmsinh Desai University, Nadiad. India. Email: drvrundashah2007@gmail.com; Orcid id: 0009-0007-9071-1322

ABSTRACT

Background: Miniscrew-Assisted Rapid Palatal Expansion (MARPE) has emerged as an effective alternative to conventional rapid palatal expansion (RPE) and surgically assisted rapid palatal expansion (SARPE) for correcting transverse maxillary deficiencies in skeletally mature patients. Although numerous studies have reported favorable skeletal outcomes, evidence regarding long-term retention protocols and post-expansion stability remains limited.

Objective: To systematically evaluate the available evidence on retention protocols and post-expansion stability following MARPE in adolescent and adult patients.

Methods: A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, with protocol registration in PROSPERO (CRD42025642633). Electronic searches were performed in MEDLINE (PubMed), Embase, Scopus, Web of Science, Cochrane Library, and Google Scholar. Studies involving patients aged ≥13 years treated with MARPE that reported retention protocols and/or post-expansion stability were included. Data regarding study characteristics, intervention details, retention methods, and stability outcomes were extracted. Risk of bias was assessed using the ROBINS-I tool.

Results: Six observational studies met the inclusion criteria. Across the included studies, MARPE demonstrated favorable long-term skeletal stability, with skeletal expansion being maintained more consistently than dentoalveolar expansion. Mild to moderate relapse was reported in all studies, with dental relapse consistently exceeding skeletal relapse. Periodontal changes, including slight reductions in buccal bone thickness and alveolar bone height, were generally minimal and clinically acceptable. Longer retention periods and appropriate retention protocols were associated with improved post-expansion stability. However, the overall quality of evidence was limited because most studies were retrospective and demonstrated moderate to serious risk of bias.

Conclusion: Current evidence suggests that MARPE provides predictable and stable skeletal expansion with acceptable long-term outcomes in adolescents and adults. Although some dentoalveolar relapse is expected, skeletal relapse remains minimal when appropriate retention protocols are followed. Well-designed prospective randomized clinical trials with standardized retention protocols and longer follow-up periods are needed to strengthen the available evidence.

KEYWORDS: Miniscrew-Assisted Rapid Palatal Expansion (MARPE); Maxillary Skeletal Expander (MSE); Retention; Post-expansion stability; Relapse; Maxillary expansion; Skeletal expansion; Systematic review; Orthodontics

INTRODUCTION

Orthodontic expansion of the maxilla has long been a cornerstone in the management of transverse discrepancies, with its origins tracing back to the mid-19th century when early clinicians introduced mechanical devices aimed at widening the maxillary arch.[1] These initial appliances gradually evolved into the concept of Rapid Palatal Expansion (RPE), which gained widespread acceptance due to its ability to separate the midpalatal suture and produce significant transverse skeletal changes, particularly in growing individuals.[2] Over time, tooth-borne expanders became the standard approach, demonstrating predictable outcomes in children and early adolescents where sutural patency allows for efficient orthopedic response.[3] However, as skeletal maturity increases, the midpalatal suture undergoes progressive interdigitation and ossification, significantly reducing its responsiveness to conventional expansion forces.[4] In such cases, traditional tooth-borne RPE often results in undesirable dentoalveolar effects rather than true skeletal expansion. These include buccal tipping of posterior teeth, alveolar bone bending, root resorption, and gingival recession, thereby compromising

periodontal health and limiting the effectiveness of treatment in late adolescents and adults.[5] Consequently, Surgically Assisted Rapid Palatal Expansion (SARPE) was introduced to overcome these limitations, enabling skeletal expansion through surgical release of the resistant sutures.[6] Although effective, SARPE is invasive, associated with increased morbidity, higher cost, and extended recovery periods, which has prompted the search for less invasive yet equally effective alternatives.[7]

The introduction of Miniscrew-Assisted Rapid Palatal Expansion (MARPE) represents a significant advancement in the evolution of maxillary expansion techniques. By incorporating temporary anchorage devices (TADs) into the expander design, MARPE shifts the point of force application from the teeth to the basal bone, thereby facilitating a more direct and effective opening of the midpalatal suture even in skeletally mature patients.[8] This bone-borne or hybrid approach minimizes the undesirable dental side effects commonly associated with conventional expanders and enhances the skeletal component of expansion.[9] As a result, MARPE has been widely regarded as a "middle-ground" modality that bridges the gap between conventional RPE and SARPE, offering a less invasive yet clinically effective solution for transverse maxillary deficiencies.[10]

Biomechanically, MARPE exerts its effects not only on the midpalatal suture but also on the surrounding circummaxillary sutural system, including the zygomaticomaxillary, frontomaxillary, and pterygopalatine articulations.[11] This results in a more parallel pattern of expansion compared to the V-shaped opening typically observed with tooth-borne expanders.[12] Furthermore, the increased skeletal-to-dental expansion ratio helps preserve the integrity of the periodontal structures by reducing excessive stress on anchor teeth.[13] Such skeletal modifications contribute to improvements in maxillary width, facial harmony, and overall craniofacial balance.[14]

In addition to its orthodontic benefits, MARPE has demonstrated significant implications for airway function and respiratory health. Expansion of the maxilla leads to a concomitant widening of the nasal floor and an increase in nasal cavity volume, thereby reducing nasal airway resistance.[15] These changes are particularly relevant in patients with compromised airway conditions, such as mouth breathing and obstructive sleep apnea (OSA), where transverse skeletal deficiency plays a contributory role.[16] Consequently, MARPE is increasingly being recognized as a multidisciplinary therapeutic modality with applications extending beyond conventional orthodontics.[17]

Despite these promising outcomes, the long-term stability of expansion achieved through MARPE remains a critical concern. Orthodontic stability is inherently influenced by the balance between the achieved skeletal changes and the adaptive capacity of the surrounding soft tissues and sutural systems.[18] Following expansion, the midpalatal suture undergoes a process of bone remodeling, while the surrounding structures exert relapse forces that may compromise the achieved transverse gain.[19] This is particularly relevant in adult patients, where reduced growth potential and increased sutural resistance may predispose to higher relapse tendencies.[20]

Although numerous studies have documented the short-term skeletal and dental effects of MARPE, there is a relative paucity of high-quality longitudinal evidence assessing its retention and post-expansion stability.[21] Most available literature focuses on immediate or short-term outcomes, leaving a significant gap in understanding the durability of treatment effects over time.[22]

Therefore, the present systematic review aims to critically evaluate the existing evidence regarding retention and post-expansion stability following MARPE. By synthesizing available longitudinal data, this review seeks to provide clinicians with evidence-based insights into the predictability and long-term effectiveness of MARPE as a definitive treatment modality for maxillary transverse discrepancies.[23]

METHODS

Protocol and registration

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The review protocol was registered in the PROSPERO database with a unique registration number CRD42025642633. Detailed protocol information can be accessed through the PROSPERO registry.

Eligibility criteria

The eligibility criteria were established based on the objectives of the present systematic review. Studies evaluating retention protocols and post-expansion stability following miniscrew-assisted rapid palatal expansion (MARPE) were considered eligible.

Studies involving adolescents and adults (≥13 years of age) undergoing MARPE treatment for transverse maxillary deficiency were included. All types of MARPE appliance designs and anchorage configurations were accepted. Studies were required to report at least one of the primary outcomes, namely post-expansion stability (skeletal and/or dental) or retention outcomes following MARPE. Secondary outcomes included relapse rates, duration and type of retention, changes in transverse dimensions over time, dental tipping, alveolar bone changes, periodontal effects, airway changes, and factors influencing stability and relapse.

The following study designs were considered eligible: randomized controlled trials, non-randomized clinical trials, prospective studies, and retrospective studies.

Studies were excluded if they included patients younger than 13 years, individuals with cleft lip and palate or other craniofacial syndromes, patients with a history of maxillofacial surgery, or those with systemic conditions affecting bone metabolism. Case reports, case series with very small sample sizes, reviews, and in vitro studies such as finite element analysis (FEA) were also excluded.

Information sources and search strategy

A structured PICOS framework was used to develop a comprehensive search strategy.

- **Population:** Late adolescent or adult patients (skeletally mature/maturing) with maxillary transverse deficiency or crossbites with no congenital deformity (Cleft Lip/Palate)
- **Intervention:** Maxillary expansion performed using MARPE (Miniscrew-Assisted Rapid Palatal Expansion) or MSE (Maxillary Skeletal Expander).
- **Comparison:** Traditional tooth-borne RPE, Surgically Assisted RPE (SARPE), or no treatment (pre-treatment vs post-treatment outcome)
- **Outcomes:**
  - **Primary:** Changes in skeletal/dental transverse dimensions (e.g., inter-molar width) and relapse rates.
  - **Secondary:** Cortical bone thickness, periodontal health, or stability measured via CBCT/digital models.
- A systematic electronic search of the literature was performed in the following databases: MEDLINE (via PubMed), Embase, Cochrane Library, Web of Science, and Scopus. Additionally, grey literature was explored using Google Scholar to identify relevant unpublished or non-indexed studies.

The search strategy was initially developed for MEDLINE and subsequently adapted for other databases. Manual searches of reference lists of included studies were also performed to identify any additional relevant articles. No restrictions were applied regarding language or publication status.

The detailed search strategy is provided in Table 1.

Database	Search strategy
Cochrane Library	("MARPE" OR "MARME" OR "mini-implant assisted rapid palatal expansion" OR "miniscrew assisted rapid palatal expansion" OR "microimplant assisted expansion" OR "bone-borne expansion") in Title, Abstract, Keywords AND ("retention" OR "retainer" OR "stability" OR "relapse") in Title, Abstract, Keywords NOT "case report" in Title, Abstract, Keywords (Word variations have been searched)
Web of Science	TS=("MARPE" OR "mini-implant assisted rapid palatal expansion" OR "miniscrew assisted rapid palatal expansion" OR "bone-borne expansion" OR "palatal expansion with mini-implants") 2) TS=("retention*" OR "relapse*" OR "stability*") 3) TS=(adult* OR adolescent*) 4) #1 AND #2 AND #3 5) TI=(case report OR case series) 6) #4 AND NOT #5
PubMed	("MARPE"[Title/Abstract] OR "mini-implant assisted rapid palatal expansion"[Title/Abstract] OR "miniscrew assisted rapid palatal expansion"[Title/Abstract] OR "bone-borne expansion"[Title/Abstract]) AND ("retention"[Title/Abstract] OR "retainer"[Title/Abstract] OR "stability"[Title/Abstract] OR "relapse"[Title/Abstract]) AND ("adult"[Title] OR "adolescent"[Title]) NOT "case report"[Title] NOT "case series"[Title]
Scopus	TITLE-ABS-KEY("MARPE" OR "mini-implant assisted rapid palatal expansion" OR "miniscrew assisted rapid palatal expansion" OR "bone-borne expansion") AND TITLE-ABS-KEY("retention" OR "retainer" OR "stability" OR "relapse") AND TITLE-ABS-KEY(adult OR adolescent) NOT TITLE-ABS-KEY("case report") NOT TITLE-ABS-KEY("case series")

Study selection, data items and collection

Eligibility assessment was conducted independently by two reviewers (Dr. Rishabh Goswami, Dr. Manisha Tripathi) based on predefined inclusion and exclusion criteria. Titles and abstracts of all retrieved records were screened, and duplicate studies were removed. Full-text articles of potentially relevant studies were then assessed for final inclusion.

Any disagreements between reviewers were resolved through discussion and consensus, and when necessary, consultation with a third reviewer (Dr. Aakash Shah). In cases where required data were missing or unclear, attempts were made to contact the corresponding authors via email.

Data extraction was performed using a standardized form. The following data items were collected:

- Study characteristics (authors, year of publication, country, journal)
- Study design and methodology
- Sample characteristics (sample size, age, sex distribution)
- Intervention details (type of MARPE appliance, miniscrew characteristics, activation protocol, retention protocol, duration of retention)
- Outcomes (post-expansion stability, relapse measurements, skeletal and dental changes, and other relevant secondary outcomes)

Risk of bias in individual studies and across studies

The methodological quality of the included studies was assessed using established tools. For randomized controlled trials, the Revised Cochrane Risk of Bias tool (RoB 2) was used. For non-randomized studies, the Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) tool was applied.

The following domains were evaluated for randomized studies:
(1) random sequence generation
(2) allocation concealment
(3) blinding of participants and personnel
(4) blinding of outcome assessment
(5) incomplete outcome data
(6) selective reporting
(7) other sources of bias
Each study was categorized as having low, unclear, or high risk of bias.
For non-randomized studies, the ROBINS-I tool assessed:
(1) bias due to confounding
(2) bias in selection of participants
(3) bias in classification of interventions
(4) bias due to deviations from intended interventions
(5) bias due to missing data
(6) bias in outcome measurement
(7) bias in selection of reported results
An overall judgment of bias (Low, Moderate, Serious, or Critical) was assigned to each study. Studies with critical risk of bias were excluded from further qualitative synthesis.
Disagreements between reviewers were resolved through discussion and consensus.

RESULTS

Study selection and characteristics

The PRISMA-based screening process resulted in the inclusion of **six studies** that fulfilled the predefined eligibility criteria. A detailed summary of the study characteristics, including study design, sample size, patient demographics, appliance design, activation protocols, and retention strategies, is presented in

Table 1.

Study	Country	Study Design	Age (Mean/Range)	MARPE Type	Activation Protocol	Retention Protocol	Follow-up Duration
Lim et al., 2017	Korea	Retrospective	21.6 ± 3.1 yrs (18.25–26.75)	MARPE (Modified Hyrax, 4 miniscrews)	1 turn/day (0.2 mm)	Post Treatment retention not mentioned	1 year post-expansion
Choi et al., 2016	Korea	Retrospective cohort	20.9 ± 2.9 yrs (18–28)	MARPE (4 miniscrews)	1/4 turn (0.2 mm) every other day	Wrap Around Retainers given	30.2 months post-treatment
Tang et al., 2021	China	Retrospective	22.14 ± 4.76 yrs (18–33)	MSE II (4 mini-implants)	1 turn/day (0.13 mm)	Post Treatment retention not mentioned	~13 months post-expansion
Ahmida et al., 2023	Canada	Retrospective	13.7 ± 1.74 yrs (11–15)	MARPE (2 miniscrews)	2 turns/day (0.5 mm)	Post Treatment retention not mentioned	2 years, 8 months post-treatment
Chen et al., 2025	The Netherlands	Prospective cohort	26.2 ± 8.2 yrs (≥16)	MARPE (4 miniscrews)	1 turn/day (0.25 mm)	Post Treatment retention not mentioned	~12.2 months post-expansion

Firinciogullari et al., 2025	Türkiye	Retrospective	13.25 ± 0.6 yrs at start	MARPE (4 miniscrews)	2 turns/day	Fixed Lingual Retainer from canine to canine in both the arches along with vacuum formed retainer for night time wear	10 years post-treatment

Table 1: Study Selection and Characteristics of the included studies

All included studies were observational in nature, comprising both retrospective and prospective designs. The sample populations consisted of adolescents and adults (≥13 years), with variations in appliance configuration and follow-up duration. All studies reported outcomes related to post-expansion stability and/or retention following MARPE.

Risk of bias within studies

The risk of bias assessment using the ROBINS-I tool for the six included studies is summarized in Table 2. Overall, the majority of the studies were judged to have a moderate to serious risk of bias, largely reflecting the inherent limitations of non-randomized, retrospective designs. The most significant sources of bias were related to confounding, particularly regarding variations in initial skeletal maturity and diverse activation protocols and selection bias stemming from the retrospective enrollment of patients based on the availability of long-term follow-up records. While measurement bias was generally low due to the widespread use of CBCT-based evaluation, the lack of explicit blinding for outcome assessors and relatively small sample sizes across several cohorts contributed to the potential for bias. One prospective cohort study presented a comparatively lower risk profile, though it remained susceptible to bias in domains common to non-randomized clinical research.

Relapse patterns following MARPE

Relapse outcomes are detailed in **Table 3**.

All studies reported some degree of relapse following MARPE. A consistent pattern observed across studies was that **dental relapse exceeded skeletal relapse**. Relapse was most pronounced during the early post-retention phase and tended to stabilize thereafter. Factors influencing relapse included retention duration, appliance design, and anchorage configuration.

Study	Skeletal Expansion Maintained	Dental Expansion Maintained	Relapse (%)	Key Findings

Lim et al., 2017	High	Moderate	Moderate	Skeletal basal bone and nasal widths are highly stable; significant relapse noted in dental and alveolar widths.
Choi et al., 2016	High	High	Mild	Skeletal expansion remains almost entirely stable; intermolar width shows minor but significant relapse post-treatment.
Tang et al., 2021	High	High	Mild–Moderate	Skeletal width increases are highly stable; suture width decreases during retention due to bone remodeling and mineralization.
Ahmida et al., 2023	High	Moderate–High	Low–Moderate	MARPE achieves greater skeletal orthopedic effects and maintains them more effectively long-term compared to conventional RPE.
Chen et al., 2025	High	Moderate	Moderate	Excellent skeletal stability (97%+); dental relapse (~19%) is primarily attributed to secondary orthodontic tooth movement.
Firinciogullari et al., 2025	High	Moderate	Moderate	Provides excellent skeletal stability even at 10-year follow-up; dental relapse is greater but predictable over the long term.

Table 3: Relapse Patterns following MARPE.

Alveolar and periodontal changes

Alveolar and periodontal outcomes are summarized in **Table 4**.

Mild reductions in buccal bone thickness and alveolar crest levels were reported; however, these changes were generally minimal and not clinically significant. Posterior dental inclination showed partial relapse toward baseline values. Overall, periodontal health remained stable across the included studies.

Study	Buccal Bone Thickness	Alveolar Crest Level	Dental Inclination	Periodontal Effects
Lim et al., 2017	Significant net reduction of 0.26 mm at the first premolar at the one-year follow-up	The buccal alveolar crest level moved apically across all measured teeth, with the first premolar showing a significant 1.54 mm vertical bone loss after one year	The first molar initially tipped buccally by 3.91° but returned to a position with no significant change in inclination compared to baseline after one year	Overall periodontal changes included a decrease in buccal bone thickness and height, which were found to be negatively affected by the patient's initial bone levels
Choi et al., 2016	The study did not directly measure buccal bone thickness	No significant changes were observed in the clinical crown heights of the maxillary canines, first premolars, or first molars at any time point during the treatment or follow-up	Not mentioned in the study	The treatment was considered periodontally stable, as there was no significant gingival recession and no obvious clinical loss of buccal attachment observed
Tang et al., 2021	This study did not measure buccal bone thickness, focusing instead on skeletal width and palatal cortical bone thickness	The study did not evaluate alveolar crest levels	Not measured in the study	Not measured in the study
Ahmida et al., 2023	Not measured in the study	Not measured in the study	Not measured in the study	Not measured in the study

Chen et al., 2025	Buccal bone thickness at the first molar showed a significant net reduction of 0.3 mm after one year, with the primary decrease occurring during the active expansion phase	This study did not evaluate vertical alveolar crest levels	The first molar initially tipped buccally by 3.8° but showed no significant net change in inclination at the one-year mark due to subsequent palatal tipping during the follow-up period	The study reported that MARPE expanded the maxilla without significant side effects such as gingival recession or loss of attachment, though a minor decrease in buccal bone thickness was noted
Firincioglullari et al., 2025	The marpe group showed significantly less reduction in buccal bone thickness at the left first molar during expansion compared to conventional rpe, and no significant differences in bone thickness were found between the groups at the 10-year follow-up	This study did not directly measure linear alveolar crest levels, focusing instead on angular measurements of alveolar bone bending to evaluate changes in the alveolar process	Marpe resulted in minimal buccal tipping (a maximum of 2°), whereas conventional rpe caused significantly greater tipping (up to 12.81°), with both groups showing minimal tipping relapse after 10 years	Treatment with MARPE resulted in **fewer dental side effects**, , such as excessive tipping and buccal bone thickness reduction, which contributed to more stable long-term dentoskeletal outcomes compared to conventional RPE

Table 4: Alveolar and Periodontal Changes

Synthesis of results

Due to heterogeneity in study design, outcome measures, and follow-up periods, a meta-analysis was not performed. However, qualitative synthesis of findings across studies (Tables 3 and 4) demonstrated consistent trends.

MARPE produced significant transverse expansion with **favorable skeletal stability** and **moderate dental relapse**. Retention duration emerged as a critical factor influencing long-term outcomes.

DISCUSSION

The evolution of maxillary expansion techniques from conventional tooth-borne appliances to miniscrew-assisted rapid palatal expansion (MARPE) represents a significant paradigm shift in contemporary orthodontics. This systematic review aimed to evaluate the clinical effectiveness, predictability, and post-expansion stability of MARPE, with particular emphasis on the interplay between skeletal expansion and dentoalveolar adaptation during the retention phase and various retention protocols. Despite the increasing clinical adoption of MARPE, there remains a conspicuous lack of high-quality randomised controlled trials evaluating long-term stability and standardized retention protocols, with most available evidence derived from observational and cohort-based studies. This limitation in the available literature creates difficulty in establishing universally accepted clinical guidelines and highlights the need for more standardized prospective studies evaluating appliance design, activation protocols, and long-term retention strategies.

Biomechanical Basis of Expansion and Skeletal Response

A fundamental finding of this review is the biomechanical advantage of MARPE in achieving true skeletal expansion through direct force application to the maxillary basal bone. Zeng et al. reported that skeletal expansion contributes approximately 48.85% of total expansion, with dental and alveolar components accounting for 43.63% and 7.52%, respectively[24]. Similarly, Choi et al. demonstrated that skeletal expansion of 1.92 mm contributed approximately 43.34% of intermolar expansion[25]. However, Tang et al. reported skeletal width increases of approximately 2.26 mm at the nasal region, suggesting that expansion is a three-dimensional phenomenon influenced by anatomical region and measurement modality[26].

The predominance of skeletal expansion observed across these studies supports the fundamental biomechanical rationale behind MARPE and explains its increasing preference in young adults where conventional tooth-borne rapid maxillary expansion often results in excessive dental tipping and undesirable periodontal side effects. The findings also suggest that MARPE is capable of producing a more orthopedically driven expansion pattern, thereby improving the overall quality and stability of transverse correction. Variations in skeletal response among studies may additionally reflect differences in age groups, bone density, appliance positioning, and imaging modalities used for assessment.

Post-Expansion Changes and Early Relapse

Despite successful expansion, all studies reported some degree of relapse, particularly within the first year following treatment. Tang et al. observed skeletal relapse ranging from 0.13 mm to 0.41 mm, corresponding to 5.75% to 19.75% depending on the anatomical region[26]. In contrast, Choi et al. reported minimal relapse, with reductions as low as 0.07 mm in skeletal width and 0.42 mm in intermolar width[25].

These discrepancies may be attributed to differences in imaging techniques and anatomical focus, as CBCT-based evaluations such as those by Tang et al. detect subtle skeletal remodelling that may not be evident in two-dimensional analyses. Importantly, relapse appears to be region-specific, with posterior skeletal structures demonstrating greater adaptive remodelling compared to anterior regions. From a clinical perspective, the presence of minor relapse should not necessarily be interpreted as treatment failure, as the craniofacial complex undergoes continuous adaptation in response to occlusal forces, muscular balance, and periodontal remodelling. Therefore, a certain degree of post-expansion narrowing may represent physiological adaptation rather than complete loss of skeletal correction.

Skeletal vs Dentoalveolar Stability

A critical distinction emerging from this review is the difference in stability between skeletal and dentoalveolar components. Chen et al. reported skeletal relapse of 0.6 ± 1.2 mm (11.6%) at the nasal floor, whereas intermolar relapse reached 3.8 ± 2.1 mm (60.2%), with interpremolar widths remaining stable[27].

These findings indicate that post-expansion narrowing is predominantly due to dentoalveolar changes rather than loss of skeletal correction. Clinically, this emphasizes the importance of differentiating between skeletal stability and dental relapse when evaluating treatment outcomes. In many cases, intermolar constriction may create the impression of complete relapse despite relatively stable skeletal expansion. This distinction is highly significant during post-treatment assessment because treatment success should not be evaluated solely on dental arch width measurements. Instead, clinicians must recognize that skeletal and dentoalveolar tissues exhibit different adaptive behaviours over time, thereby necessitating individualized retention protocols targeting posterior dental stability.

Sutural Adaptation and Craniofacial Remodelling

MARPE induces not only midpalatal suture separation but also changes in the circummaxillary sutural system. Ahmida et al. demonstrated that multiple sutures, including frontonasal, frontomaxillary, and intermaxillary sutures, showed significant widening immediately after expansion; however, at long-term follow-up, only the midpalatal suture maintained a significant increase[28].

This suggests that long-term transverse stability is primarily dependent on midpalatal sutural consolidation, while surrounding craniofacial structures undergo adaptive remodelling over time. These findings reinforce the concept that MARPE should not be considered merely a localized expansion procedure limited to the palate, but rather a treatment modality capable of producing broader craniofacial skeletal adaptations. At the same time, the gradual reduction in circummaxillary sutural changes at long-term follow-up indicates that the craniofacial skeleton undergoes progressive functional and structural reorganization following expansion. Such adaptive remodelling may contribute to the stabilization of skeletal forces over time.

Long-Term Stability and Comparative Outcomes

Long-term studies further demonstrate the superiority of MARPE over conventional rapid palatal expansion. Firinciogullari et al. reported relapse rates of approximately 30% in MARPE-treated patients compared to 80% in those treated with conventional RPE over a 10-year period[30]. Additionally, Zeng et al. reported a high overall success rate of approximately 93.87%, with relapse remaining clinically acceptable[24].

These findings reinforce the concept that skeletal anchorage significantly enhances long-term stability by minimizing dentoalveolar tipping. The comparatively lower relapse associated with MARPE may be attributed to the direct transmission of forces to the basal bone rather than to the dentition alone. Nevertheless, complete elimination of relapse remains unrealistic because long-term orthodontic stability is influenced by multiple factors including occlusal adaptation, soft tissue pressures, growth changes, and patient compliance. Therefore, MARPE should be viewed as a modality that improves the predictability and magnitude of skeletal stability rather than one that completely prevents relapse.

Determinants of Stability

Stability following MARPE appears to be influenced by several factors. Tang et al. reported that greater palatal cortical bone thickness was associated with improved stability, while unfavorable palatal plane inclination increased relapse[26]. Choi et al. observed that the amount of initial expansion correlated positively with post-expansion changes[25]. Conversely, Chen et al. found no significant association between stability and age, sex, or midpalatal suture maturation stage[27].

These findings suggest that local anatomical and biomechanical factors may play a more significant role than demographic variables in determining post-expansion stability. Clinically, this highlights the importance of individualized treatment planning and detailed anatomical assessment prior to expansion. The increasing use of CBCT imaging may therefore assist clinicians in evaluating palatal bone quality, skeletal morphology, and potential risk factors associated with relapse. Furthermore, the findings imply that chronological age alone may not be a reliable predictor of treatment outcome, and greater emphasis should instead be placed on patient-specific anatomical characteristics.

Retention Strategies Following MARPE

The long-term success of MARPE is critically dependent on retention protocols, particularly during the early post-expansion phase. Choi et al. emphasized the importance of maintaining the MARPE appliance passively for approximately 3–6 months to allow for sutural ossification[25]. Lim et al. highlighted that stabilization of dental and skeletal changes requires careful monitoring during this retention period[26].

Following removal of the expander, the use of transpalatal arches has been advocated to maintain intermolar width and prevent buccal segment collapse[30]. Cantarella et al. further emphasized the importance of rigid archwire stabilization during the transitional orthodontic phase to maintain transverse dimensions and control dentoalveolar effects[12]. From a clinical standpoint, the retention phase should be regarded as an active continuation of treatment rather than merely a passive observation period. Inadequate retention may compromise otherwise successful skeletal expansion outcomes due to the persistent tendency for dentoalveolar adaptation and posterior constriction. The absence of universally accepted retention protocols within the literature further indicates the need for future prospective studies evaluating optimal retention duration and appliance design following MARPE.

Integrated Interpretation and Clinical Perspective

Taken together, the findings of the present review suggest that MARPE provides a stable skeletal foundation for transverse expansion, while dentoalveolar components remain the primary contributors to relapse. The variability observed across studies indicates that stability is multifactorial, influenced by anatomical characteristics, treatment mechanics, and retention strategies. While skeletal relapse remains minimal, the high degree of intermolar relapse underscores the importance of posterior stabilization and long-term retention.

From a clinical perspective, the success of MARPE extends beyond achieving expansion and relies heavily on the clinician's ability to implement individualized retention protocols tailored to the patient's anatomical and functional characteristics. The integration of skeletal anchorage with appropriate retention strategies allows for improved long-term outcomes compared to conventional expansion methods. Overall, the available evidence supports MARPE as a predictable and biologically favourable alternative to conventional expansion approaches in appropriately selected patients, particularly due to its ability to maximize skeletal effects while minimizing undesirable dentoalveolar consequences. However, long-term success remains dependent on careful case selection, biomechanical control, patient compliance, and retention management, all of which play a crucial role in maintaining stable treatment outcomes.

CONCLUSION

This systematic review was undertaken to evaluate the retention protocols and post-expansion stability following Miniscrew-Assisted Rapid Palatal Expansion (MARPE) in adolescent and adult patients with transverse maxillary deficiency. Based on the findings of the included studies, the following conclusions can be drawn:

1. MARPE demonstrated favorable skeletal expansion with relatively high long-term stability across most included studies. Skeletal transverse gains achieved through midpalatal suture expansion were maintained more predictably than dentoalveolar expansion.
2. All included studies reported some degree of relapse following expansion; however, dental relapse was consistently greater than skeletal relapse. Intermolar constriction and dentoalveolar adaptation represented the primary contributors to post-treatment changes, whereas skeletal relapse remained comparatively minimal and clinically acceptable.
3. Retention duration and retention protocol played a significant role in maintaining post-expansion stability. Prolonged passive retention with the MARPE appliance, followed by additional orthodontic stabilization, was associated with improved maintenance of transverse dimensions and reduced relapse tendencies.
4. MARPE exhibited favorable periodontal and alveolar outcomes compared to conventional tooth-borne expansion methods. Although mild reductions in buccal bone thickness, alveolar bone height, and dental tipping were observed, these changes were generally limited and clinically acceptable in most studies.
5. The findings of this review suggest that anatomical and biomechanical factors, including palatal bone thickness, appliance design, anchorage configuration, and expansion magnitude, may influence long-term stability more significantly than demographic factors such as age or sex. Individualized treatment planning therefore remains essential for achieving predictable outcomes.
6. Despite the promising clinical outcomes associated with MARPE, the overall quality of available evidence remains limited because most included studies were observational and retrospective in design, with methodological heterogeneity, variable follow-up periods, and non-standardized retention protocols.

The findings of the present systematic review support MARPE as a predictable and biologically favorable treatment modality for the correction of transverse maxillary deficiency in skeletally mature and maturing patients. Its ability to produce greater skeletal expansion with comparatively reduced dentoalveolar side effects makes it a valuable alternative to conventional rapid palatal expansion approaches. However, long-term success remains highly dependent on appropriate retention management, biomechanical control, and careful patient selection. Further well-designed prospective clinical studies with standardized protocols and extended follow-up periods are necessary to establish stronger evidence regarding long-term retention and post-expansion stability following MARPE.

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