



Research Paper

Positional Variations of Mini-Implant Assisted Rapid Palatal Expansion (MARPE) and Their Effects on Skeletal and Dental Structures: A Systematic Review

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Abstract

Background: Mini-implant assisted rapid palatal expansion (MARPE) is an effective non-surgical solution for maxillary transverse deficiency. However, the influence of implant positioning (anterior vs. middle) on skeletal and dental structures requires further investigation.

Objective: To systematically review studies comparing anterior and middle mini-implant placement in MARPE and analyze their effects on skeletal expansion, dental movement, and soft tissue changes.

Methods: A systematic search was performed in PubMed, ScienceDirect, Cochrane Library, and Google Scholar (2000–March 2024) following PRISMA guidelines. Studies assessing MARPE with anterior vs. middle implant positioning were included. Data extraction included skeletal expansion, dental effects, and soft tissue changes.

Results: Out of 4,106 retrieved studies, 14 met the inclusion criteria. The key findings were:

- Anterior placement → Greater skeletal expansion, but increased dental tipping
- Middle placement → More uniform expansion, reduced dentoalveolar effects
- Limited studies on soft tissue impact

Conclusion: MARPE remains an effective alternative to surgical expansion. Middle-positioned implants provide more controlled expansion and stability, whereas anterior placement offers greater but less controlled expansion. Further studies are needed on long-term retention and soft tissue effects.

Keywords: Mini-implant assisted rapid palatal expansion (MARPE), skeletal expansion, dental tipping, transverse maxillary deficiency, orthodontic stability

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I. Introduction

Maxillary transverse deficiency affects 30% of orthodontic patients and contributes to malocclusion, crossbites, and functional shifts^{1,2}. While traditional rapid palatal expansion (RPE) is effective in young patients, its success in adults is limited due to mid-palatal suture ossification^{3,4}.

MARPE uses mini-implants to distribute expansion forces to the mid-palatal suture, minimizing dentoalveolar effects^{5,6}. However, implant positioning affects skeletal expansion, dental stability, and relapse rates⁷.

This systematic review evaluates the impact of anterior vs. middle implant placement in MARPE, focusing on skeletal, dental, and soft tissue effects.

II. Materials and Methods.

A systematic search was performed in:

Pubmed, Sciencedirect, Cochrane Library, Google Scholar with the PICO question as stated below from 2000 to March 2024, using the following keywords: (Mini-implant assisted rapid palatal expansion) or (MARPE, Mini-Screw Assisted RPE) or (Anterior vs. Middle Implant Placement in MARPE)

PICO Format	
Population	Adults undergoing mini-implant supported rapid palatal expansion (tooth tissue borne and tissue borne)
Intervention	Middle placement of Mini implant in Mini implants supported rapid palatal expander (tooth tissue borne and tissue borne)
Comparison	Anterior Placement of mini implant in Mini Implant supported rapid palatal expander (tooth tissue borne and tissue borne)
Outcome	Effects and type of skeletal expansion , Effect on soft tissue, teeth and airway

Eligibility Criteria

Inclusion Criteria:

- Adult patient with constricted arches (unilateral and bilateral posterior)requiring maxillary expansion.
- Palatal expansion using any design of Mini implant assisted Rapid palatal expansion (MARPE) irrespective of number of mini implants in Anterior or Posterior placement of Mini Implants.
- AllRandomisedControlledTrials,ControlledClinical Trials, Prospective and RetrospectiveStudies.

Exclusion Criteria:

- Casereportsandcaseseries,laboratorystudies,descriptivestudies,epidemiologic studies, books and documents, expert opinions, reviews andclinicaltrials werenot included in the study
- Studies with no relevance to mini implant assisted rapid palatal expansion supported were excluded.
- Studies describing other than anterior and middle positional placement of mini-implants used for min implant supported rapid palatal expander were excluded from this study

Data Extraction & Quality Assessment

- Skeletal expansion (mm) & mid-palatal suture opening

Dental tipping (°) & alveolar bone response

Soft tissue adaptations (nasal width, periodontal effects)

Two independent reviewers evaluated study quality and bias risk.

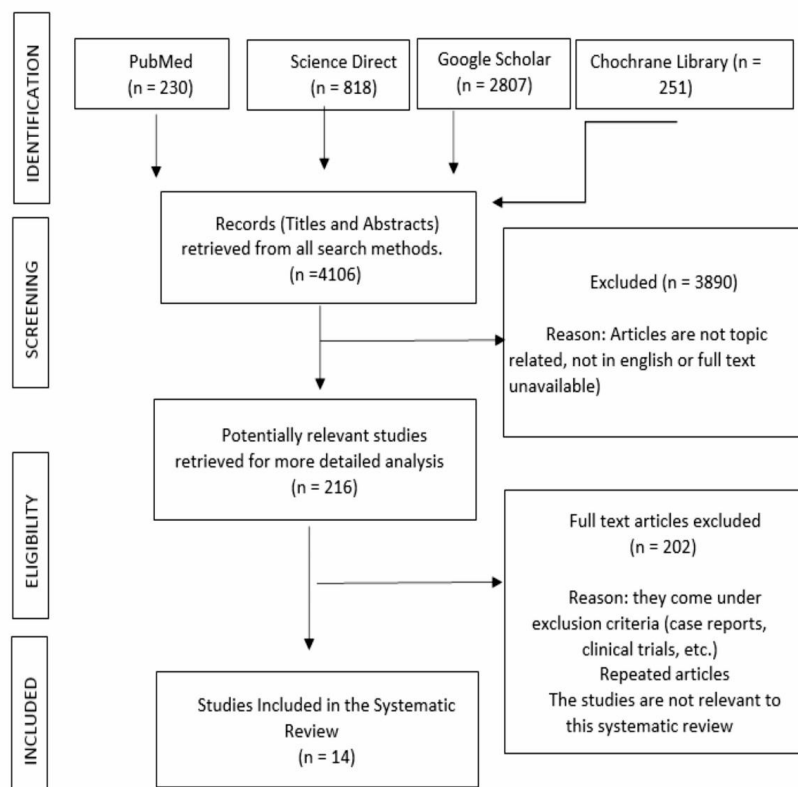


Figure 1 - PRISMA flowchart illustrating study selection process

III. Results

Study Characteristics included in table 1

Table 1 characteristics of Studies						
S. No	Study	Placement of mini implant/mini screws	Average age (years)	Effect on skeletal hard tissue	Effect on dental structures	Effect on Soft tissue
1	Jung, jin park Kjo 2017	Custom made MARPE 02 third rugae area and 02 at para mid sagital area	19 patients 20.1± 2.4 YEARS	IMW width (5.4 mm) accounted for 37.0% of the skeletal expansion at the J-point (2.0 mm),	2.2% of the alveolar expansion at the cemento-enamel junction (1.2 mm), and 40.7% of the dental expansion at the cusp tip (2.2 mm)	N/A
2	Cheng zong et al Sem in ortho 2019	MSE appliance with 02 screws at anterior region and 02 at posterior region	22 (11 male, 11 female) Patients 14.97 ± 6.16	Total expansion of 5.41 ± 2.18 mm was achieved, 59.23 ± 17.75% of which was attributed to skeletal expansion	(3.15 ± 1.64 mm) with the first molars exhibiting buccal tipping of 2.56 ± 2.64°.	N/A
3	Lu lin et al Angle orthod 2013	C expander (bone borne) 02 beneath the palatal slope and alveolar ridge between canine and premolar 8mm beneath and 02 at first molar region	28 female (group 1, C-expander, n = 15, age = 18.1 ± 4.4 years) and tooth-borne (group 2, hyrax, n = 13, age = 17.4 ± 3.4 years)	Mid palatal suture opened with least nasal floor and greatest increase at the hard palate below 5 mm	Hyrax group showed more buccal tipping of the tooth axes than did the C-expander group in all areas. Alveolar bending was more pronounced in the hyrax group, except in the second molar region. Transverse dental expansion at the dental apices was similar in both groups at the first premolar and the first molar	N/A
4	Sung huang choi et al Angle orthod 2016	Marpe with two anterior screw at third rugae and two screws in the parallel direction of first molar	69 patients 20 patients with marpe followed by straight wire appliance (mean age, 20.9 ± 2.9 years) follow up patients 30.2 ± 13.2 month	Midpalatal suture opened in a triangular shape, with the smallest increase observed in N-N (1.07 mm) and the largest increase observed in intermolar width	Expansion of IMW was 3.94 times greater than that of J-J	Gingival recession was not significant, averaging 0.57 mm to 0.86 mm
5	Clemet and krishnaswamy APOS trends 2017	MSE four screws placed 2 at third rugae and 2 screws placed anterior to the hard and soft palate	10 patients Age group of 19–24 and with the mean age of 21.5 years	The intersutural expansion at the median palatine level of the I molar, II PM, and I PM was on an average 4.5 mm, while At the canine, it was 4.8 mm, and at the incisors, it was 5.3 mm The intersutural expansion at the median palatine level of the I molar, II PM, and I PM was on an average 4.5 mm, while At the canine, it was 4.8 mm, and at the incisors, it was 5.3 mm. The intersutural	Ental changes significant amount of expansion was seen in the IMW, Inter II PMW, Inter I PMW, and ICW	N/A

				expansion at the median palatine level of the I molar, II PM, and I PM was on an average 4.5 mm, while at the canine, it was 4.8 mm, and at the incisors, it was 5.3 mm. A nonparallel expansion of the midpalatal suture with the greatest widening at the incisor and least at the molar region.		
6	Daniele Cantarella et al Prog in ortho 2017	MSE appliance	15 patients with mean age of 17.2 years; range, 13.9–26.2 years	The split at anterior nasal spine (ANS) and at posterior nasal spine (PNS) was 4.8 and 4.3 mm midpalatal suture was almost perfectly parallel antero-posteriorly	N/A	N/A
7	Hyun mock lim et al KJO 2017	MARPE two anterior miniscrews were implanted in the rugae area and two posterior miniscrews in the paramidsagittal area	24 patients mean age, 21.6 ± 3.1 years; range, 18.25–26.75 years	Expansion at T1 included 39.1% skeletal (nasal floor), 7.1% alveolar T2 included 43.2% skeletal, 15.0% alveolar	Buccal tipping of 3.91° and 1.78°, respectively (p < 0.01), indicating a 2.07° buccal tipping of the tooth itself During T1–T2, the tooth axis decreased by 2.34°, while the alveolar axis increased further by 0.49°, indicating that the tooth itself became more upright by 2.30°	N/A
8	Peter ngan et al APOS trends 2018	MSE On the inclines of the anterior palate distal to the second or third rugae (anterior position) On the flat surface of the palate 1 mm anterior to the soft palate near the level of the permanent first molar (posterior position).	8 patients 2 females, 6 males; mean age of 21.9 ± 1.5 years	461% skeletal, 12% alveolar bone bending, and 48% dental tipping. Pattern of midpalatal suture opening was found to be parallel in both the coronal and axial planes.	Absolute dental tipping ranged from 4.17° to 4.96° and the BBT was reduced by an average of 39% measured at the premolars and molars	Buccal bone thickness decreased by 0.27 mm to 0.60 mm for the first molars after expansion.
9	Olivera et al Angle ortho 2021	MSE	28 patients 20-37 years	815 of skeletal expansion in age of 20-27 years	N/A	N/A
10	Calil et al Ajodo 2021	MARPE (2 anteriors and 2 posterior) Self ligatingbrackets(Damon brackets)	37 patients Group 1(mean age 19.55yr) Group 2 (mean 24.92 years)	N/A	Greater decrease in buccal bone thickness of canines and premolars in the self-ligating group, the premolars presented a greater buccal inclination in the self-ligating group, and the intercanine and intermolar distances and nasal	N/A

					base and jugula widths showed significantly greater increases in the MARPE group than in the self-ligating group.	
11	Ning et al AJODO 2023	Group 1:tissue-borne miniscrew-assisted rapid palatal expansion (MARPE) Group B (n = 32) comprising patients treated with tooth-borne MARPE Group C – Fixed orthodontic treatment	91 patients 16-25 years Group A- 29patients Group B-32 patients Group C- 30patients	Increases in the width of the maxilla, nasal, and arch width	Increases the molar torque, the height of the alveolar bone and the root volume decreased significantly . Group B displayed more increases in buccal tipping, alveolar bone loss, and root volume loss than group A	N/A
12	Moon et al Angle orthod 200	MSE I and C expander	MSE group (n = 24, age = 19.2 ± 5.9 years) and C-expander group (n = 24, age = 18.1 ± 4.5 years)	The MSE group produced greater dental expansion ($P < .05$), whereas skeletal expansion was similar in both groups. Buccal alveolar bone height loss and thickness changes were greater in the MSE group	The C expander group had more alveolar bone inclination change ($P < .01$), and the MSE group had more buccal tipping of the anchorage teeth Buccal bone height loss in the MSE group had a negative correlation with initial buccal bone thickness.	N/A
13	Tang et al Angle orthod 2021	Mse II	31 young adults (19 women and 12 men, mean age 22.14 ± 4.76 years, range: 18–33 years)	The width increases were found in a triangular pattern, changes in skeletal width were generally stable, although some small amounts of relapse thicker cortical bone of the palate and/or a flatter palatal plane appeared to demonstrate better stability after MARME	N/A	N/A
14	Elkenawy et al Prog in ortho 2020	MSE	31 non-growing patients with an average age of 20.4 years old	Total expansion was 4.98 mm at the anterior nasal spine (ANS) and 4.77 mm at the posterior nasal spine (PNS)	N/A	N/A

Table 1: Study Characteristics and Mini-Implant Positioning

Skeletal Expansion Findings

Table 2: Skeletal Expansion with Anterior vs. Middle Implant Placement

Implant Position	Mid-Palatal Suture Opening (mm)	Maxillary Width Increase (mm)
Anterior	5.4 – 6.2 mm	3.2 – 5.1 mm
Middle	4.8 – 5.5 mm	3.8 – 4.5 mm

- Anterior placement leads to greater expansion but more dental tipping
- Middle placement causes more uniform skeletal expansion

Dental Changes

Table 3: Buccal Tipping in MARPE

Implant Position	Buccal Tipping (°)	Alveolar Bone Thickness Change (mm)
Anterior	3.91° – 4.96°	-0.27 mm to -0.60 mm
Middle	1.78° – 2.34°	-0.13 mm to -0.41 mm

- Anterior implants leads to more buccal tipping, thinner alveolar bone
- Middle implants tends to cause less dental tipping, more stable expansion

IV. Conclusion

MARPE is a non-surgical alternative for maxillary expansion in adults.

- Middle placement → More stable, controlled expansion
- Anterior placement → Greater but less predictable expansion

Further RCTs and longitudinal studies are needed to assess long-term retention and soft tissue changes.

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