IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 21, Issue 4 Ser.11 (April. 2022), PP 43-57
www.iosrjournals.org

Comparative Evaluation of Maxillary Skeletal Expansion using Mini-implant Assisted Rapid Palatal Expander with and without Micro osteoperforation in the Mid Palatal Suture region: A Randomized Clinical Trial.

Dr. Madhura J. Pednekar[1], Dr. Vivek Patni[2], Dr. Ravindranath V.K.[3]
[1,2,3]*(Department of Orthodontics and Dentofacial Orthopaedics, MGM Dental College and Hospital, India)*

Abstract
Introduction: *Maxillary transverse deficiency is one of the most commonly undiagnosed problem. MARPE has generated much interest in the recent times, with good amount of supporting evidences. Thus, in this study, we are performing micro osteoperforation, a minimally invasive technique of accelerated orthodontics in the mid palatal suture region for Rapid Maxillary Expansion (RME) using mini- implants for skeletal anchorage to investigate whether micro osteoperforation makes mid palatal suture opening more predictable by reducing the resistance and optimizing its opening.*
Materials And Methods: *Total of 22 subjects fitting the inclusion criteria were considered for this study and they were randomly divided into two groups of MARPE without MOP in mid palatal suture region (Group A) and MARPE with MOP in mid palatal suture region (Group B). Measurement was done on cast with digital vernier calliper from the cusp tip of maxillary canine on either sides and from central fossae of maxillary first molars on either sides. CBCT scans of all patients were recorded and pre and post expansion parameters were evaluated.*
Results: *On the study casts, a statistically significant increase was seen only in the intermolar width with higher values in MARPE with MOP group. On the CBCT scans, on the coronal slice, statistically significant higher values of difference between post and pre expansion values was seen for the Nasal cavity width and Zygoma to Zygoma width in the MARPE with MOP group whereas Frontonasal level width difference showed higher values in the MARPE only group. In the alveolar changes, with regards to the difference of cortical buccal thickness, statistically significant higher value was seen in MARPE with MOP group for the left molar only. Among dental changes, amongst the linear values, only the inter canine width difference was higher in MARPE only group. Amongst the angular values, the difference in right canine angulation showed statistically significant higher magnitude in MARPE only group. Statistically significant difference was noticed in difference of right and left first premolar angulation with higher values in MARPE with MOP group, and in the left second premolar angulation with higher values in MARPE with MOP group, whereas the right second premolar angulation difference was higher for the MARPE only group.*
Conclusion: *MARPE with Micro osteoperforation in the mid palatal suture region gives more skeletal expansion in the nasal cavity and interzygomatic width region as compared to MARPE without Micro osteoperforation. Also, greater dental changes especially in the premolar region and minimal tooth angulation changes were seen in the MARPE with Micro osteoperforation in the mid palatal suture region group as compared to the MARPE without Micro osteoperforation group.*
Key Words: *MARPE, Micro osteoperforation, Maxillary expansion, Maxillary skeletal expansion, Mid palatal suture, Cone beam computed tomogram*

Date of Submission: 08-04-2022 Date of Acceptance: 25-04-2022

I. Introduction

Maxillary transverse deficiency is one of the most commonly undiagnosed or ignored problem.[1] In 1990, Proffit and White claimed that 30% of adult patients have transverse discrepancy.[2] Transverse discrepancies such as facial asymmetry, midline deviation, posterior crossbite and scissors bite disrupt the occlusal relationship and hinder orthodontic correction to achieve normal occlusion. Therefore, diagnosis and treatment of transverse relationship is as important as that of anteroposterior discrepancy.[1] In 1965, Haas corroborated the possibility of treating the transverse discrepancy by separating the mid palatine suture to orthopedically expand the maxilla.[3] Subsequently, the method has become increasingly popular, and today it is accepted as a reliable and effective treatment procedure in correction of various malocclusions. When the

applied forces surpass the resistance of palatal sutural articulation, disruption and splitting of the mid palatal suture starts and expansion occurs.

MARPE has generated much interest in the recent times, with good amount of supporting evidences. The addition of mini implants in the expander screw not only reduces the effect of excessive forces on the anchor teeth, but also allows expansion in young adults or adult age group, which are so far considered to be in the surgical assisted RPE group. Mini-implants are successfully used with palatal expanders to work as anchors and to achieve more efficient skeletal expansion while decreasing unwanted dental effects.

Over the past decade, the Regional Acceleratory Phenomenon (RAP) induced by surgical trauma has gained emphasis for reducing orthodontic treatment time.[4] The regional acceleratory phenomenon (RAP) is a complex reaction of mammalian tissues to diverse noxious stimuli. This phenomenon transpires regionally, involves both hard and soft tissues, and is characterized by an advancement and domination of most ongoing normal vital tissue processes.The various methods used to induce the regional acceleratory phenomenon can be classified into the following categories[5,6]:

1. Drugs like vitamin D, prostaglandin, interleukins, parathyroid hormone, misoprostol
2. Surgical Methods like Corticotomy, piezocision, micro osteoperforation
3. Physical/ Mechanical stimulation like LASER, vibration.

Teixeira et al. have shown that biological principles can be activated to expedite bone remodelling using Micro osteoperforation (MOP).[7] In MOP, minuscule perforations are created within the bone. MOP increases local levels of inflammatory cytokine activity around a tooth, which increases bone remodeling by inciting osteoclastic activity and causing transient osteopenia.[8] MOP causes very little discomfort to the patient, can be done chair side in a few minutes and can be used in conjunction with any treatment modality including TADs, aligners, etc.

In the literature, a few case reports have shown the use of corticotomy method as an aid in the expansion of the upper arch, called CAE (corticotomy-assisted expansion) for treatment of maxillary transverse deficiency.[9,10] The recommended corticotomy procedure is bilateral decortication of the alveolar, buccal, and palatine bones and the use of dental expanders. According to Hassan et al[10], the corticotomy method during expansion can reduce the resistance to expansion, resulting in faster tooth movement, and lessen the side effects of conventional expansion. There have been sporadic suggestions that MOP can be used in cases where palatal split is not occurring within the first few days of expander activation.

Thus, in this study, we are performing MOP, a minimally invasive technique of accelerated orthodontics in the mid palatal suture region for Rapid Maxillary Expansion (RME) using mini- implants for skeletal anchorage to investigate whether MOP makes mid palatal suture opening more predictable by reducing the resistance and optimizing its opening. The study intends to compare efficacy of rapid maxillary expansion using mini-implants with MARPE done with and without MOP. The rationale of carrying out this study is to guide clinicians to select the appropriate treatment protocol and achieve best results for their patients.

II. Materials And Methods

Total of 22 subjects fitting the inclusion criteria were considered for this study and they were randomly divided into two groups of MARPE without MOP in mid palatal suture region (Group A) and MARPE with MOP in mid palatal suture region (Group B). The study protocol was approved by Mahatma Gandhi Mission's Dental College & Hospital Institutional Ethical Review Committee with approval no. MGM/DCH/IERC/17/18.

Inclusion Criteria was: subjects in the age group of 18 to 40 years of either gender indicated for skeletal maxillary expansion, with good oral hygiene and healthy periodontal tissues, no prior history of orthodontic treatment and/ or orthognathic surgery, no severe dentofacial anomalies or syndromic conditions, no radiographic evidence of bone loss, no systemic disease or conditions. Case history, informed consent and records consisting of photographs, radiographs, CBCT scan, study models of each subject were obtained. Randomization was done for allocation of patients to Group A or Group B using the chit system and single blinding was done.

The appliance (FAVEX skeletal expansion screw and activation key from FavAnchorTM SAS, India) was fabricated by sizing the molar bands, taking a pick- up impression, and pouring it in stone. Placing the appliance on the working cast in the first molar region, the lateral arms were contoured to the curvature of the palatal shelves and soldered to the molar bands. The central body of the expander flushed against the palate and the supporting arms had 2 mm clearance from the lateral wall of palate. The appliance was then retrieved from the working cast and its position was checked in the patient's mouth and then cemented on the maxillary first molars using GIC luting cement. In the Group B, micro osteoperforation was done (using hand held Inter Dental Osteoperforation Instrument by SH Pitkar Ortho Tools, India) in the mid palatal region anterior to the screw and up to 6 mm away from the incisive papilla. The patient was then taught how to activate the expander appliance with the key.

Expansion protocol followed was to begin with 2 turns/ day for first 2 weeks. (Till appearance of midline diastema), followed by 1 turn/ day for the next 6 weeks.

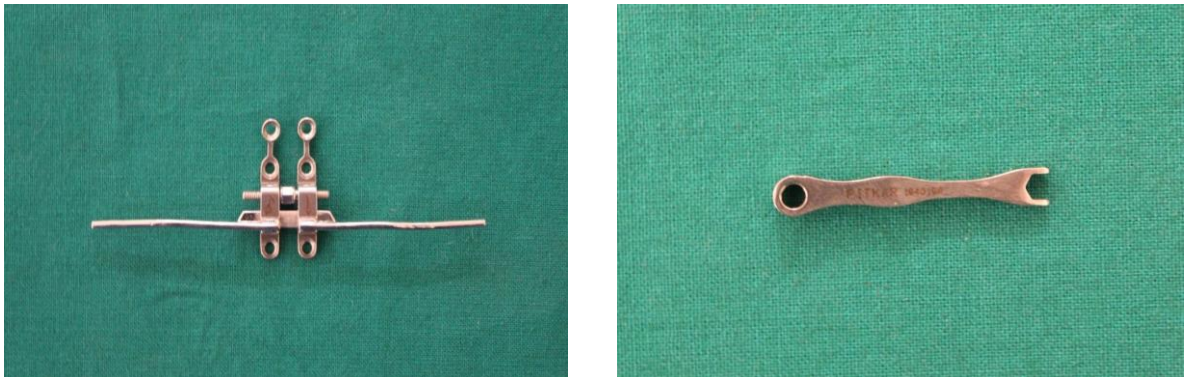


Figure 1: FAVEX skeletal expansion screw and activation key (FavAnchorTM SAS, India).

Figure 2: Inter Dental Osteoperforation Instrument (hand held) (SH Pitkar Ortho Tools, India)

Patients were called for evaluation according to the following schedule:
T0- at the beginning of treatment T1- on the day following appliance placement
T2- 6th day after appliance placement T3- 10th day after appliance placement
T4- at the end of 3 weeks T5- at the end of 4 weeks T6- at the end of 5 weeks
T7- at the end of 6 weeks T8- at the end of 7 weeks T9- at the end of 8 weeks.

At each visit, putty bite wafer impression was taken. Cast was poured with OrthokalTM dental stone. Measurement was done on cast with digital vernier calliper from the cusp tip of maxillary canine on either sides and from central fossae of maxillary first molars on either sides. CBCT scans of all patients were recorded at the same radiology centre. Measurements on CBCT scans with 1:1 calibration was performed and evaluated at the end of the expansion regimen. Occlusal radiograph was taken at T3 to check for suture opening. CBCT parameters measured were:-

Table 1: CBCT parameters measured

Sr. No	Landmarks	Description
1.	S	Medial limits of the palatine process at left and right central incisors - (S1, S2) canine (S3, S4) first premolars (S5, S6) second premolars (S7, S8) First molar (S9, S10)
2.	AL	Medial limits of the alveolar process at left and right canine (AL1, AL2) first premolars (AL3, AL4) second premolars (AL5, AL6) and first molar (AL7, AL8)
3.	IC	Medial points of palatal crown tip at canine
4.	I PM	Medial points of palatal crown tip at first premolars
5.	II PM	Medial points of palatal crown tip at second premolars
6.	IM	Medial points of palatal crown tip at first molar
7.	TOL and TOR	Inclination between the palatal root axis and nasal floor (NF) at left (TOL) and right (TOR) Canine (TOR1, TOL2) first premolars (TOR3, TOL4) second premolars (TOR5, TOL6) and first molar (TOR7,TOL8)
8.	CBT	Cortical Bone Thickness
9.	N	Lateral most border of nasal cavity

10.	Z	Lateral most border of zygoma
11.	F	Lateral most border of frontonasal level

***Statistical Procedures*:**

Data obtained was compiled on a MS Office Excel Sheet (v 2019, Microsoft Redmond Campus, Redmond, Washington, United States). Data was subjected to statistical analysis using Statistical package for Social Sciences (SPSS v 26.0, IBM). Descriptive statistics like frequencies and percentage for categorical data, Mean & SD for numerical data was performed. Inter group comparison (2 groups) was done using t test. For all the statistical tests, $p<0.05$ was considered to be statistically significant, keeping α error at 5% and β error at 20%, thus giving a power to the study as 80%.

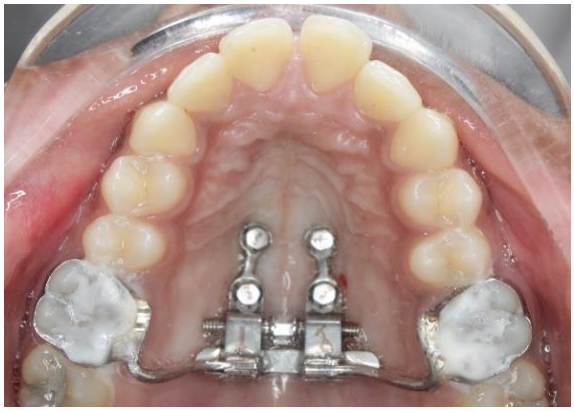


Figure 3: Intraoral image of maxillary occlusal view showing a case of MARPE

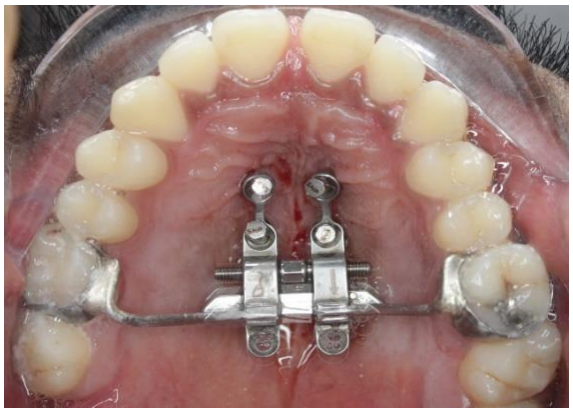


Figure 4: Intraoral image of maxillary occlusal view showing a case of MARPE with MOP in mid palatal suture region

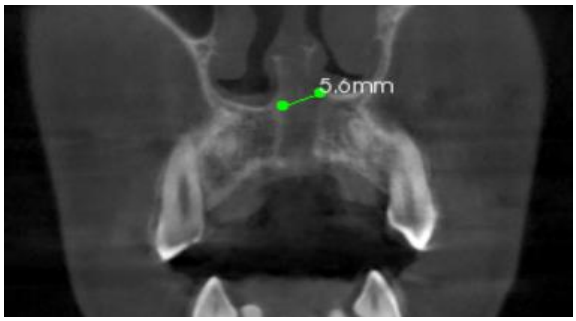


Figure 5: Medial limits of palatine process at left and right canine

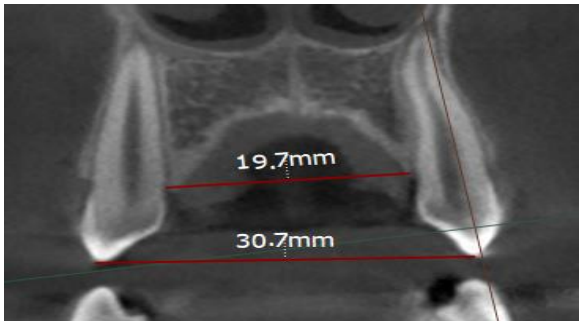


Figure 6: Medial limits of the alveolar process at left and right canine and Medial points of palatal crown tip at canine

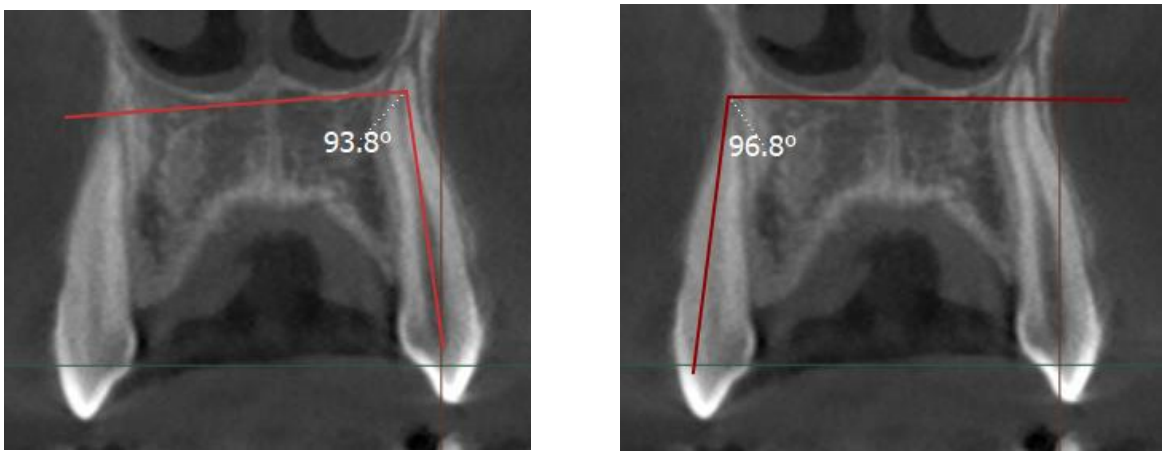


Figure 7: Inclination between the palatal root axis and NF at left and right canine

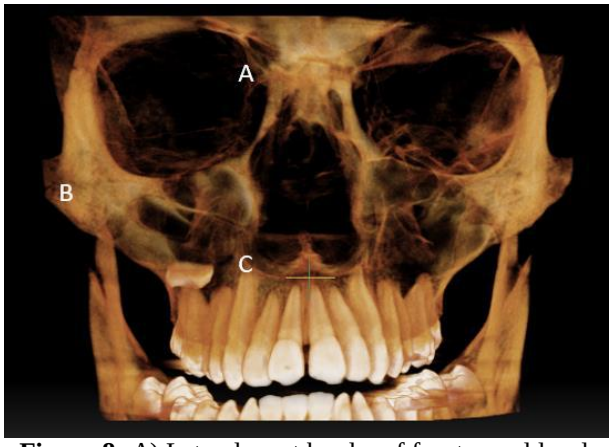


Figure 8: A) Lateral most border of frontonasal level
B) Lateral most border of zygoma
C) Lateral most border of nasal cavity

III. Results

Inter group comparison of values (Table 2) showed that there was a statistically highly significant / significant difference seen for the values between the groups ($p<0.01, 0.05$) for
Inter molar width T8-T0 difference with higher values in group 1
Nasal cavity width Pre expansion with higher values in group 1
Nasal cavity width Post expansion with higher values in group 1
Zygoma to Zygoma width Pre expansion with higher values in group 2
Zygoma to Zygoma width Post expansion with higher values in group 2
Frontonasal level width Post expansion with higher values in group 2
Alveolar level at canines Pre expansion with higher values in group 1
Canine angulation right Post expansion with higher values in group 2
First premolar angulation left Pre expansion with higher values in group 2
Second premolar angulation left Pre expansion with higher values in group 2
Second premolar angulation left Post expansion with higher values in group 2
Second premolar angulation right Pre expansion with higher values in group 1
Second premolar angulation right Post expansion with higher values in group 1
Molar angulation left Pre expansion with higher values in group 2.

Inter group comparison of differences in values (Table 3) showed that there was a statistically highly significant / significant difference seen for the values between the groups ($p<0.01, 0.05$) for
Nasal cavity width difference with higher values in group 1
Zygoma to Zygoma width difference with higher values in group 1
Frontonasal level width difference with higher values in group 2
Left cortical buccal thickness difference with higher values in group 1
Intercanine width difference with higher values in group 2
Right Canine angulation difference with higher values in group 2
Difference in left first premolar angulation with higher values in group 1
Difference in right first premolar angulation with higher values in group 1
Difference in left second premolar angulation with higher values in group 1
Difference in right second premolar angulation with higher values in group 2.

* = statistically significant difference ($p<0.05$)
** = statistically highly significant difference ($p<0.01$)
# = non significant difference ($p>0.05$) for all tables

Table 2: Inter group comparison of values

	Group	N	Mean	Std. Deviation	Std. Error Mean	T value	p value
Skeletal level							
ICW T8-T0 DIFFERENCE	1	11	3.07	2.432	.733	-.533	.600#
	2	11	3.50	1.140	.344		
IMW T8-T0 DIFFERENCE	1	11	5.34	1.329	.401	3.080	.006**
	2	11	3.43	1.572	.474		
Suture opening at incisors Pre expansion	1	11	.00	.000[a]	.000		
	2	11	.00	.000[a]	.000		
Suture opening at incisors post expansion	1	11	4.163636	1.8996172	.5727561	.472	.642#
	2	11	3.793636	1.7757943	.5354221		
Suture opening at canines Pre expansion	1	11	.00	.000[a]	.000		
	2	11	.00	.000[a]	.000		
Suture opening at canines Post expansion	1	11	3.8818	1.83892	.55446	-.344	.734#
	2	11	4.1409	1.68980	.50949		
Suture opening at I premolar Pre expansion	1	11	.00	.000[a]	.000		

	2	11	.00	.000[a]	.000		
Suture opening at I premolar Post expansion	1	11	3.845455	1.8543806	.5591168	.637	.531#
	2	11	3.381818	1.5458449	.4660898		
Suture opening at II premolar Pre expansion	1	11	.00	.000[a]	.000		
	2	11	.00	.000[a]	.000		
Suture opening at II premolar Post expansion	1	11	3.281818	1.3585420	.4096158	.089	.930#
	2	11	3.223636	1.6964626	.5115027		
Suture opening at molar Pre expansion	1	11	.00	.000[a]	.000		
	2	11	.00	.000[a]	.000		
Suture opening at molar Post expansion	1	11	2.7573	.99908	.30123	-1.037	.312#
	2	11	3.3100	1.45914	.43995		
Nasal cavity width Pre expansion	1	11	29.9091	2.63000	.79298	4.718	.000**
	2	11	25.4036	1.76533	.53227		
Nasal cavity width Post expansion	1	11	32.74545	1.3793938	.4159029	10.487	.000**
	2	11	26.47636	1.4242701	.4294336		
Zygoma to Zygoma width Pre expansion	1	11	99.1373	1.27823	.38540	-4.923	.000**
	2	11	104.3564	3.27538	.98757		
Zygoma to Zygoma width Post expansion	1	11	99.9409	.99252	.29925	-4.791	.000**
	2	11	104.6618	3.11365	.93880		
Frontonasal level width Pre expansion	1	11	17.20272	1.0931248	.3295895	-1.729	.099#
	2	11	18.10545	1.3425078	.4047813		
Frontonasal level width Post expansion	1	11	17.23454	1.1375708	.3429905	-2.236	.037*
	2	11	18.34727	1.1954003	.3604267		
Alveolar level							
Alveolar level at canines Pre expansion	1	11	20.781818	2.0725917	.6249099	2.124	.046*
	2	11	19.370000	.7518643	.2266956		
Alveolar level at canines Post expansion	1	11	24.2364	3.51490	1.05978	1.145	.266#
	2	11	22.7400	2.53567	.76453		
Alveolar level at I premolar Pre expansion	1	11	24.5000	2.54833	.76835	.218	.830#
	2	11	24.3209	.97268	.29327		
Alveolar level at I premolar Post expansion	1	11	27.5273	3.20908	.96757	-.015	.989#
	2	11	27.5455	2.62996	.79296		

Alveolar level at II premolar Pre expansion	1	11	30.00000	2.4490815	.7384258	-.233	.818#
	2	11	30.22545	2.0655041	.6227729		
Alveolar level at II premolar Post expansion	1	11	32.63636	3.4363564	1.036100	-.615	.545#
	2	11	33.44909	2.7167092	.8191187		
Alveolar level at molar Pre expansion	1	11	31.38181	1.7594421	.5304917	-1.620	.121#
	2	11	32.94545	2.6745219	.8063987		
Alveolar level at molar Post expansion	1	11	34.80000	3.2594478	.9827605	-1.260	.222#
	2	11	36.87000	4.3640119	1.315799		
Cortical buccal thickness L Pre expansion	1	11	1.480909	.4713906	.1421296	.552	.587#
	2	11	1.375455	.4230925	.1275672		
Cortical buccal thickness L Post expansion	1	11	1.345455	.3984059	.1201239	-.120	.906#
	2	11	1.364545	.3457561	.1042494		
Cortical buccal thickness R Pre expansion	1	11	1.632727	.4365568	.1316268	.328	.746#
	2	11	1.554545	.6597630	.1989260		
Cortical buccal thickness R Post expansion	1	11	1.503636	.4134555	.1246615	.015	.988#
	2	11	1.500909	.4144021	.1249469		
Dental level							
Intercanine width Pre expansion	1	11	31.4682	3.28544	.99060	1.850	.079#
	2	11	29.0764	2.75457	.83053		
Intercanine width Post expansion	1	11	34.56363	4.1081073	1.238641	.978	.340#
	2	11	33.02090	3.2437801	.9780365		
Inter I premolar width Pre expansion	1	11	25.6773	2.18533	.65890	-1.330	.199#
	2	11	26.7073	1.35124	.40742		
Inter I premolar width Post expansion	1	11	29.4455	4.21269	1.27017	-.647	.525#
	2	11	30.3582	2.03920	.61484		
Inter II premolar width Pre expansion	1	11	32.18181	1.6023846	.4831371	-.899	.379#
	2	11	32.96454	2.4027250	.7244488		
Inter II premolar width Post expansion	1	11	35.63636	2.7192914	.8198972	-1.349	.192#
	2	11	37.06818	2.2344566	.6737140		
Intermolar width Pre expansion	1	11	37.30909	1.4508305	.4374418	-1.790	.089#
	2	11	38.52000	1.7110231	.5158929		
Intermolar width Post expansion	1	11	39.43181	4.2433638	1.279422	-1.683	.108#
	2	11	42.09181	3.0794572	.9284913		

Canine angulation left Pre expansion	1	11	92.9091	4.10986	1.23917	-1.454	.161#
	2	11	96.8255	7.92984	2.39094		
Canine angulation left Post expansion	1	11	92.636	6.3289	1.9082	-1.391	.179#
	2	11	97.091	8.5288	2.5715		
Canine angulation right Pre expansion	1	11	98.273	4.7559	1.4339	-.449	.659#
	2	11	99.209	5.0314	1.5170		
Canine angulation right Post expansion	1	11	96.727	4.6495	1.4019	-2.531	.020*
	2	11	101.109	3.3676	1.0154		
I premolar angulation left Pre expansion	1	11	79.2727	.90453	.27273	-7.861	.000**
	2	11	88.7418	3.89159	1.17336		
I premolar angulation left Post expansion	1	11	86.3636	2.29228	.69115	-.771	.450#
	2	11	87.3600	3.62331	1.09247		
I premolar angulation right Pre expansion	1	11	88.8182	5.03623	1.51848	-.579	.569#
	2	11	90.2582	6.53079	1.96911		
I Premolar angulation right Post expansion	1	11	94.7273	3.69028	1.11266	2.060	.053#
	2	11	90.4327	5.84884	1.76349		
II premolar angulation left Pre expansion	1	11	77.72727	2.6491851	.7987594	-4.123	.001**
	2	11	84.83090	5.0633298	1.526651		
II premolar angulation left Post expansion	1	11	82.3636	1.20605	.36364	-2.834	.010*
	2	11	85.8709	3.92282	1.18277		
II premolar angulation right Pre expansion	1	11	91.8182	1.40130	.42251	6.029	.000**
	2	11	83.9036	4.12244	1.24296		
II premolar angulation right Post expansion	1	11	89.8182	.75076	.22636	3.860	.001**
	2	11	86.4400	2.80407	.84546		
Molar angulation left Pre expansion	1	11	95.2727	1.42063	.42834	-2.835	.010*
	2	11	99.9764	5.31655	1.60300		
Molar angulation left Post expansion	1	11	95.1818	3.12468	.94213	-1.942	.066#
	2	11	99.0945	5.90721	1.78109		
Molar angulation right Pre expansion	1	11	94.2727	6.43570	1.94044	-1.143	.267#
	2	11	96.8800	3.97638	1.19892		
Molar angulation right Post expansion	1	11	95.0909	6.62502	1.99752	-.805	.430#
	2	11	96.7800	2.12452	.64057		

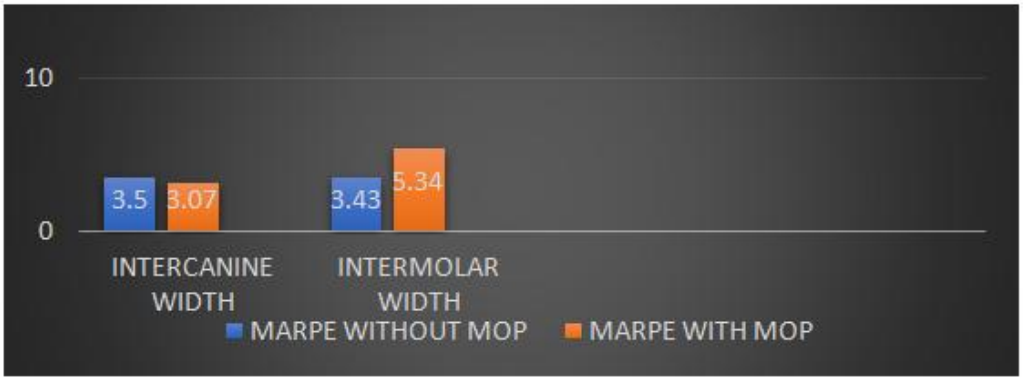
a. t cannot be computed because the standard deviations of both groups are 0.
b. t cannot be computed because at least one of the groups is empty.

Table 3: Inter group comparison of difference in values

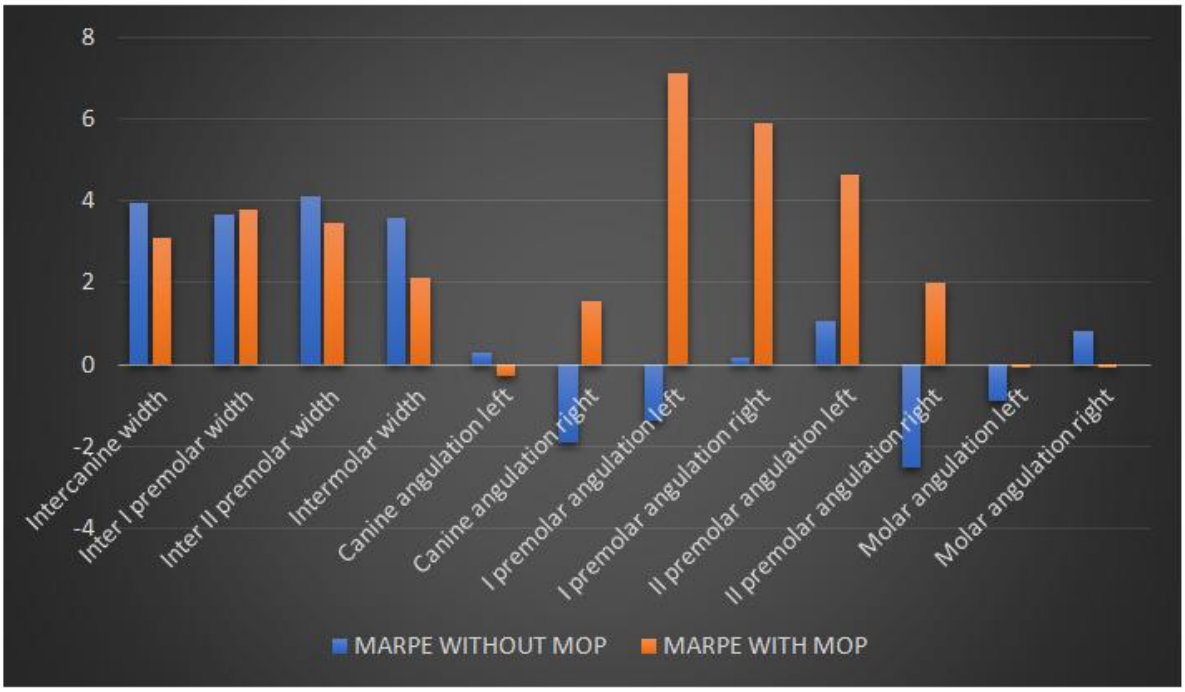
Group	N	Mean	Std. Deviation	Std. Error Mean	T value	p value
Skeletal level						
Suture opening at incisors 1 difference	11	4.163636	1.8996172	.5727561	.472	.642#
2	11	3.793636	1.7757943	.5354221		
Suture opening at canines 1 difference	11	3.8818	1.83892	.55446	-.344	.734#
2	11	4.1409	1.68980	.50949		
Suture opening at I 1 premolar difference	11	3.845455	1.8543806	.5591168	.637	.531#
2	11	3.381818	1.5458449	.4660898		
Suture opening at II 1 premolar difference	11	3.281818	1.3585420	.4096158	.089	.930#
2	11	3.223636	1.6964626	.5115027		
Suture opening at molar 1 difference	11	2.7573	.99908	.30123	-1.037	.312#
2	11	3.3100	1.45914	.43995		
Nasal cavity width 1 difference	11	2.836364	1.4596388	.4400977	3.615	.002**
2	11	1.072727	.6979411	.2104372		
Zygoma to Zygoma width 1 difference	11	.803636	.3387115	.1021253	3.800	.001**
2	11	.305455	.2726303	.0822011		
Frontonasal level width 1 difference	11	.031818	.1010760	.0304756	-3.035	.007**
2	11	.241818	.2060009	.0621116		
Alveolar level						
Alveolar level at canines 1 difference	11	3.454545	1.5756672	.4750816	.094	.926#
2	11	3.370000	2.5463778	.7677618		
Alveolar level at I premolar 1 diff	11	3.027273	.7471157	.2252638	-.265	.793#
2	11	3.224545	2.3503164	.7086471		
Alveolar level at II 1 premolar difference	11	2.636364	1.0874491	.3278782	-1.412	.173#
2	11	3.223636	.8493559	.2560904		
Alveolar level at molar 1 difference	11	3.418182	1.6636215	.5016007	-.475	.640#
2	11	3.924545	3.1162650	.9395892		
Cortical buccal thickness L 1 difference	11	.135455	.1059588	.0319478	2.291	.033*
2	11	.010909	.1459078	.0439929		
Cortical buccal thickness R 1 difference	11	.129091	.1432100	.0431794	.577	.570#

	2	11	.053636	.4091521	.1233640		
Dental level							
Intercanine width difference	1	11	3.095455	.8816049	.2658139	-2.155	.044*
	2	11	3.944545	.9645347	.2908182		
Inter I premolar width difference	1	11	3.768182	2.1668263	.6533227	.138	.892#
	2	11	3.650909	1.8170330	.5478561		
Inter II premolar width difference	1	11	3.454545	1.2948850	.3904225	-.946	.356#
	2	11	4.103636	1.8719149	.5644036		
Intermolar width difference	1	11	2.122727	2.9894283	.9013466	-1.314	.204#
	2	11	3.571818	2.1085389	.6357484		
Canine angulation left difference	1	11	-.272727	3.2891005	.9917011	-.396	.696#
	2	11	.265455	3.0738131	.9267895		
Canine angulation right difference	1	11	1.545455	1.2135598	.3659020	2.533	.020*
	2	11	-1.900000	4.3455725	1.3102394		
I premolar angulation left difference	1	11	7.090909	1.9725387	.5947428	6.719	.000**
	2	11	-1.381818	3.6877685	1.1119040		
I premolar angulation right difference	1	11	5.909091	1.4459976	.4359847	3.111	.006**
	2	11	.174545	5.9408356	1.7912293		
II premolar angulation left difference	1	11	4.636364	2.5405797	.7660136	2.729	.013*
	2	11	1.040000	3.5567401	1.0723975		
II premolar angulation right difference	1	11	2.000000	1.0954451	.3302891	3.294	.004**
	2	11	-2.536364	4.4346979	1.3371117		
Molar angulation left difference	1	11	-.090909	1.8140863	.5469676	.855	.403#
	2	11	-.881818	2.4762141	.7466066		
Molar angulation right difference	1	11	.818182	.4045199	.1219673	1.083	.292#
	2	11	-.100000	2.7828043	.8390471		

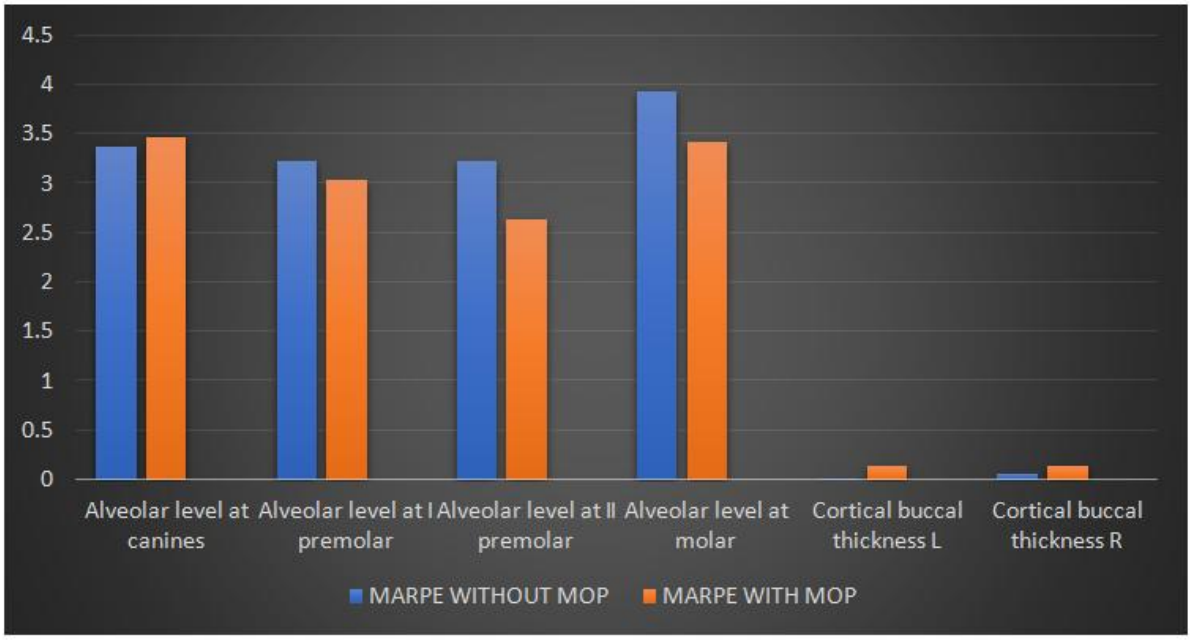
a. t cannot be computed because at least one of the groups is empty.



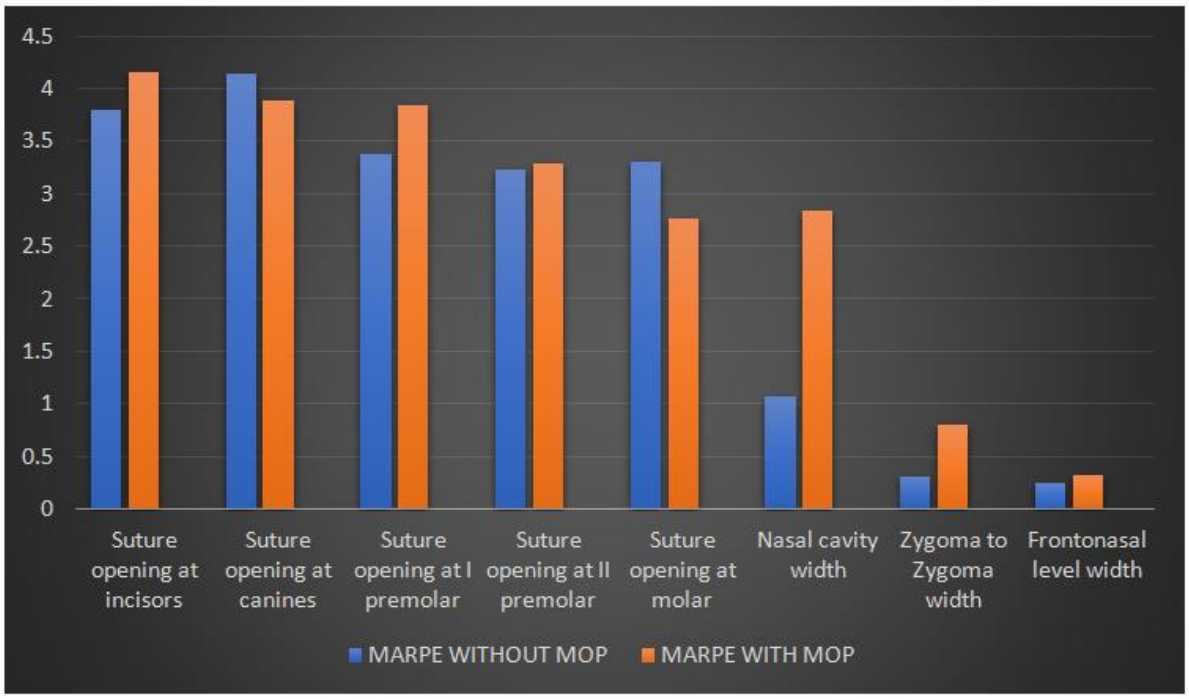
Graph 1: Average difference in intercanine and intermolar width using MARPE with and without MOP (in mm)



Graph 2: Average difference in dental CBCT parameters using MARPE with and without MOP (in mm for width and degree for angulation)



Graph 3: Average difference in alveolar CBCT parameters using MARPE with and without MOP (in mm)



Graph 4: Average difference in skeletal CBCT parameters using MARPE with and without MOP (in mm)

IV. Discussion

MARPE has shown significant results, as comprehended from previous literature reviews.11,12 The MARPE device is indicated for the correction of transverse maxillary deficiency and posterior crossbite, especially in nongrowing patients as an alternative to surgically assisted rapid palatal expansion (SARPE), since rapid palatal expansion may not be the choice in these patients due to heavy interdigitation of the mid palatal suture, making it harder to split the two halves of the maxilla conventionally by using tooth anchored expanders.13 Though SARPE shows low morbidity, chiefly when compared with other orthognathic surgical procedures, many complications like haemorrhage, gingival recession, injury to maxillary nerves, infection, pain, devitalization of teeth, sinus infection and impingement on the palatal soft tissue have been reported.14

Over the past decade, the Regional Acceleratory Phenomenon (RAP) induced by surgical trauma has become popular for reducing orthodontic treatment time.4 Many studies have reported an increase in the activity of inflammatory markers like chemokines and cytokines in reaction to orthodontic forces. Chemokines play a principal role in the recruitment of osteoclast precursor cells, and cytokines, directly or indirectly, through the prostaglandin E2 pathway and the RANK/RANKL pathway, leading to the differentiation of precursor osteoclast cells into mature osteoclasts. Thus, it is rational to presume that increasing the expression of these factors, by surgically irritating the bone tissue should speed up tooth movement. 5,6 This has led to the evolution of minimally invasive surgical procedures for inducing RAP for e.g. MOP, corticotomy, low level laser therapy, vibration, etc.4

Hassan et al. reported that expansion in conjunction with corticotomy, defined as decortication on the buccal and palatal walls of the alveolar bone, has been shown to be an effective technique in the treatment of transverse maxillary deficiency in adults and have suggested that the technique may provide greater stability of expansion and better periodontal health than conventional expansion. However, there may be side effects of the corticotomy method such as mild bone loss and loss of gingiva.15 To avoid this, they recommended the use of bone grafts to conserve the periodontium as described in certain studies.16 In addition, subcutaneous hematomas and postoperative swelling and discomfort were also observed with the corticotomy procedure.In order to minimize the surgical procedure and reduce postoperative discomfort, other techniques were advised.8 Tsai et al17 compared the effects of corticotomy and bone micro osteoperforations and concluded that both techniques increased bone remodelling and there were no significant differences between them. Therefore, the minimally invasive surgical procedure of corticopuncture could be used as an adjunct to the MARPE technique as it may be beneficial in adult patients who present with resistance of the mid palatal suture opening due to the heavy interlocking of these structures.

In the study by Lee18 who introduced the concept of implant assisted expansion in 2010, they found an increase in intermolar width on study models of 8.3 mm (50.3 – 40 mm) and an increase of 2.7 mm (37.7 – 35 mm) in the intercanine width. The angulation value of long axis of the first molar showed minimal change of 1 degree pre and post expansion.

There is only one study by Suzuki SS19 et al in 2018 who have demonstrated two case reports using MARPE and MOP in mid palatal suture. They illustrated a case report of a 35 year old Brazilian female Caucasian patient presenting with maxillary transverse deficiency. Her treatment began with an orthopaedic correction of the transverse problem using a MARPE device but after many unsuccessful attempts to activate the expander, corticopunctures were done along the mid palatal suture. The result of this protocol showed that there was opening of the mid palatal suture observed by CBCT images, showing skeletal results, suture split of 3.14mm (premolar area) and 2.06 mm (molar area), an increase of 4.3mm (premolar) and 3.03mm (molar) in basal bone width, 4.43mm (premolar) and 3.1mm (molar) in cortical bone width, and minimal dental effects (mean of 1.2° of tooth tipping). They have also demonstrated a second case where corticopuncture procedure was done prior to MARPE insertion with steps involving nerve block anesthesia, corticopuncture procedure performed using contra-angle electric screwdriver, maxillary skeletal expander cementation and miniscrew insertion. At the end of procedure, expansion was successful and occlusal X-ray showed midpalatal suture split.

The results of our study show that there was a statistically significant difference seen for the values between the groups ($p< 0.01$) for the inter molar width difference which showed higher values in group B(MARPE with MOP).

Among the skeletal parameters assessed on CBCT scans in our study, there was a statistically significant difference observed in nasal cavity width and the zygoma to zygoma width with higher values in MARPE with MOP group. Frontonasal level width difference showed higher values in the MARPE only group. Hence, in the coronal view perspective of the MARPE with MOP group, the opening observed was more pyramidal or inverted V shaped with the base at the nasal cavity and apex at the frontonasal suture region, as compared to the MARPE only group. This finding is similar to expansion pattern reported by conventional RPE20,21 SARPE,22 and MARPE.23 However the outcomes achieved by Suzuki SS et al19 differ as their CBCT evaluation of two cases treated using MARPE showed parallel split of the mid palatal suture in a coronal view, which means that the amount of suture opening in the lower portion, near the cervical region of the incisors and in the upper portion of the maxilla near the nasal cavity was similar. Among the alveolar parameters, the difference in the cortical buccal thickness exhibited statistically significant higher value in MARPE with MOP group for the left first molar only.

Despite the fact that the appliance was skeletally anchored, buccal tipping of the molars in a few cases was recorded. This is similar to prior reports using MARPE and RPE.24 This could be ascribed to the incapacity of the stabilizing wires from transferring expansion forces to the molars. The crown tipping can also be due to the play present between the mini implant and the insertion slot of mini implant, as reported by Carlson et al.11 Coming to the dental changes, amongst the linear values, only the inter canine width difference was higher in MARPE only group. Amongst the angular values, the difference in right canine angulation showed statistically significant higher magnitude in MARPE only group. Statistically significant difference was noticed in difference of right and left first premolar angulation with higher values in MARPE with MOP group, and in the left second premolar angulation with higher values in MARPE with MOP group, whereas the right second premolar angulation difference was higher for the MARPE only group.

As Micro osteoperforation is considered to be a safe, simple, cost and time effective procedure, with negligible side effects causing bearable pain to the patient, which can be performed chair side by the orthodontist using a simple Inter Dental Osteoperforation instrument, and considering the rigidity of the circumfacial structure in adults, MARPE with MOP might serve as an efficient and predictable treatment modality which can deliver sufficient expansive force minimizing the detrimental effects on the dentoalveolar complex in young adults with transverse maxillary discrepancy.

We endeavoured to make this study flawless and reproducible, but still few shortcomings were unavoidable. This trial was conducted for a short duration and thus post treatment retention of the treatment results could not be evaluated. The sample size for the study was limited to 22 patients. For further long term research purposes a larger sample size should be contemplated. It is known that other areas of resistance can play a role during maxillary expansion such as piriform aperture pillars (at the anterior region), zygomatic buttresses (laterally) and pterygoid junctions (posteriorly).14,25 These areas were not inspected in the our study. The present study utilizes CBCT scans for pre and post expansion evaluation.

Although the versatility of CBCT and imaging software for identifying dimensional changes has been reported26, CBCT images can display noise, cupping artifacts or scatter27 and may include beam hardening and scatter around orthodontic appliances and other limitations may include motion artifacts.

V. Conclusion

MARPE with Micro osteoperforation in the mid palatal suture region gives more skeletal expansion in the nasal cavity and interzygomatic width region as compared to MARPE without Micro osteoperforation.

Also, greater dental changes especially in the premolar region and minimal tooth angulation changes were seen in the MARPE with Micro osteoperforation in the mid palatal suture region group as compared to the MARPE without Micro osteoperforation group.

References

[1]. Lee KJ, Choi SH, Choi TH, Shi KK. Maxillary transverse expansion in adults: Rationale, appliance design, and treatment outcomes. Seminars Orthodontics 2018;24(1);52-65.
[2]. Proffit WR, White Jr RP. Who needs surgical-orthodontic treatment?. Int J Adult Orthodon Orthognath Surg. 1990;5(2):81.
[3]. Haas AJ. The treatment of maxillary deficiency by opening the midpalatal suture. Angle Orthod. 1965;35(3):200-17.
[4]. Shenava S, Nayak USK, Bhaskar V, Nayak A. Accelerated Orthodontics – A Review. Int J Sci Study. 2014;1(5):35-39.
[5]. de Albuquerque Taddei SR, Andrade Jr I, Queiroz-Junior CM, Garlet TP, Garlet GP, de Queiroz Cunha F et al. Role of CCR2 in orthodontic tooth movement. Am J Orthod Dentofacial Orthop. 2012;141(2):153-60.
[6]. Uematsu S, Mogi M, Deguchi T. Interleukin (IL)-1β, IL-6, tumor necrosis factor-α, epidermal growth factor, and β2-microglobulin levels are elevated in gingival crevicular fluid during human orthodontic tooth movement. J Dent Res. 1996;75(1):562-7.
[7]. Teixeira CC, Khoo E, Tran J, Chartres I, Liu Y, Thant LM et al. Cytokine expression and accelerated tooth movement. J Dent Res. 2010;89(10):1135-41.
[8]. Alikhani M, Raptis M, Zoldan B, Sangsuwon C, Lee YB, Alyami B et al. Effect of micro-osteoperforations on the rate of tooth movement. Am J Orthod Dentofacial Orthop. 2013;144(5):639-48.
[9]. Echchadi ME, Benchikh B, Bellamine M, Kim SH. Corticotomy-assisted rapid
[10]. maxillary expansion: A novel approach with a 3-year follow-up. Am J Orthod Dentofacial Orthop. 2015;148(1):138-53.
[11]. Hassan AH, AlGhamdi AT, Al-Fraidi AA, Al-Hubail A, Hajrassy MK. Unilateral cross bite treated by corticotomy-assisted expansion: two case reports. Head Face Med. 2010;6(1):6.
[12]. Carlson C, Sung J, McComb RW, Machado AW, Moon W. Microimplant-assisted rapid palatal expansion appliance to orthopedically correct transverse maxillary deficiency in an adult. Am J Orthod Dentofacial Orthop. 2016;149(5):716-28.
[13]. Clement EA, Krishnaswamy NR. Skeletal and dentoalveolar changes after skeletal anchorage-assisted rapid palatal expansion in young adults: a cone beam computed tomography study. APOS Trends Orthod. 2017;7(3):113-9.
[14]. Celenk-Koca T, Erdinc AE, Hazar S, Harris L, English JD, Akyalcin S. Evaluation of miniscrew-supported rapid maxillary expansion in adolescents: A prospective
[15]. Randomized clinical trial. Angle Orthod. 2018;88(6):702-709.
[16]. Suri L, Taneja P. Surgically assisted rapid palatal expansion: a literature review. Am J Orthod Dentofacial Orthop. 2008;133(2):290-302.
[17]. Hassan AH, Al-Fraidi AA, Al-Saeed SH. Corticotomy-assisted orthodontic treatment. Open Dent J. 2010;4:159.
[18]. Murphy KG, Wilcko MT, Wilcko WM, Ferguson DJ. Periodontal accelerated osteogenic orthodontics: a description of the surgical technique. J Oral Maxillofac Surg. 2009;67(10):2160-6.
[19]. Tsai CY, Yang TK, Hsieh HY, Yang LY. Comparison of the effects of micro- osteoperforation and corticision on the rate of orthodontic tooth movement in rats. Angle Orthod. 2016;86(4):558-64.
[20]. Lee KJ, Park YC, Park JY, Hwang WS. Miniscrew-assisted nonsurgical palatal expansion before orthognathic surgery for a patient with severe mandibular prognathism. Am J Orthod Dentofacial Orthop. 2010;137(6):830-9.
[21]. Suzuki SS, Braga LF, Fujii DN, Moon W, Suzuki H. Corticopuncture Facilitated Microimplant-Assisted Rapid Palatal Expansion. Case Rep Dent. 2018 Dec 6;2018:1392895.
[22]. Haas A. Gross reactions to the widening of the maxillary dental arch of the pig by
[23]. splitting the hard palate. Am J Orthod 1959;45:868.
[24]. Haas AJ. Palatal expansion: Just the beginning of dentofacial orthopedics. Am J
[25]. Orthod 1970;57:219 55.
[26]. Tausche E, Hansen L, Hietschold V, Lagravère MO, Harzer W. Three dimensional evaluation of surgically assisted implant bone borne rapid maxillary expansion: A pilot study. Am J Orthod Dentofacial Orthop 2007;131 4 Suppl:S92 9.
[27]. Park JJ, Park YC, Lee KJ, Cha JY, Tahk JH, Choi YJ. Skeletal and dentoalveolar
[28]. changes after miniscrew assisted rapid palatal expansion in young adults: A cone beam computed tomography study. Korean J Orthod 2017;47:77 86.
[29]. Lin L, Ahn HW, Kim SJ, Moon SC, Kim SH, Nelson G. Tooth-borne vs bone-borne rapid maxillary expanders in late adolescence. Angle Orthod. 2015;85(2):253-62.
[30]. Möhlhenrich SC, Modabber A, Kniha K, Peters F, Steiner T, Hölzle F et al. Simulation of three surgical techniques combined with two different bone-borne forces for surgically assisted rapid palatal expansion of the maxillofacial complex: a finite element analysis. Int J Oral Maxillofac Surg. 2017;46(10):1306- 14.
[31]. Lin Y. University of UCLA, Dissertation Presented for Degree of Masters of Science in Dentistry [Comparison of Skeletal and Dental Changes with MSE (Maxillary Skeletal Expander) and Hyrax Appliance using CBCT Imaging]; 2015 UCLA Electronic Theses and Dissertations.
[32]. Abdelkarim A. Cone-Beam Computed Tomography in Orthodontics. J Dent. 2019;7(3):89.

Dr. Madhura J. Pednekar, et. al. "Comparative Evaluation of Maxillary Skeletal Expansion using Mini-implant Assisted Rapid Palatal Expander with and without Micro osteoperforation in the Mid Palatal Suture region: A Randomized Clinical Trial." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 21(04), 2022, pp. 43-57.