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Evaluation of treatment changes with rapid maxillary expansion using computed tomography scan: A comprehensive review

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Abstract
The aim of the study was to review in detail, the skeletal, dental and soft-tissue effects of Rapid Maxillary Expansion in young group of patients using Computed Tomographic Scan. The review is conducted through an electronic and manual searches which includes PubMed, Ovid, Cochrane, and Web of Science using the keywords. Searches includes the original studies which were conducted from the January 2000 to May 2020 amongst patients from 6 to 18 years using Hyrax, Haas-type and butterfly-type expanders. Based on the inclusion criteria, 23 relevant articles containing 298 patients were selected to evaluate changes related to skeletal, dental, soft-tissues and airway by assessing Computed Tomography scan. Significant effects have been observed at the mid-palatal suture due to the separation of two hemi-maxillae that led to an increase in the palatal volume, maxillary arch perimeter and correction of posterior crossbite. Changes were also recorded at the circum-maxillary sutures with maximum effects noted in internasal and nasomaxillary sutures. Other observations includes dental changes like buccal tipping of the maxillary posterior anchored teeth, increase in nasal and upper airway dimensions. Few side-effects of Rapid Maxillary Expansion includes recession of alveolar bone and dehiscence in cases of excessive dental tipping, dorsal hump on the nose with flattening of the nasal tip. Interpreting the outcomes with Computed Tomography scan strengthen the orthodontist's precision in determining the 3-dimension effects with greater specificity. However, more number of Computed Tomography studies on soft-tissue changes and airway effects are required to understand comprehensive mechanics of the procedure.

Keywords: Rapid maxillary expansion, computed tomography scan, skeletal, dental, soft, tissue, retention

1. Introduction

Rapid Maxillary Expansion (RME) is a technique used to increase the maxillary arch width by separation of the suture which allows the upper and the lower arches to match transversely in to occlusion [1, 2]. This landmark procedure was introduced in 1860 by Emerson Colon Angell [3] who used a simple screw appliance between maxillary premolars to achieve the expansion. He successfully widened the arch one-quarter inch in just a span of 2 weeks. As the technique gained popularity by the efforts of Andrew Haas in 1961, it was then incorporated in to main stream orthodontic practice as non-extraction modality of treatment. RME is now extensively used procedure to treat multiple problems like posterior cross-bite due to constricted maxillary arch, deficient arch perimeter, excessive curve of Wilson [4], narrow smile [5] and constricted airway [6]. Literatures suggest beneficial effects of RME on circummaxillary sutures like zygomatico-temporal, zygomatico-frontal and zygomatico-maxillary sutures [7] which aids in correction of sagittal dimension of maxilla in cases of class II [8] and class III malocclusion [9]. It is also found to be useful in eruption of impacted incisors and canines [10, 11]. The effects of RME includes improvement in conductive hearing loss [12] by allowing eustachian tube to become more patent by stretching of the levator and tensor veli palatine muscles and helps in treating specific cases of nocturnal enuresis [13].

Identifying the impact of RME at various levels of treatment has always been a challenge. Various authors have studied the result of RME using cephalograms, postero-anterior head films and occlusal radiographs [14-19].

The aforementioned radiographic techniques only quantify the changes related to the expansion with inability to identify the standard landmarks due to superimpositions of various skeletal structures [20]. In recent years, conventional 2-dimensional radiographic techniques have been substituted with more advanced 3-dimensional imaging system, the computed Tomography (CT) and Cone-Beam Computed Tomography (CBCT) scans. The superior image of both hard and soft-tissues obtained by CT scan addresses RME's effects on various maxillofacial structures including airway patency [21].

The intent of this article was to assess and review all the possible literatures available on effects of rapid maxillary expansion at the level of skeletal, dental, and soft-tissues including upper airway changes utilizing computed tomography.

2. Materials and methods

2.1 Protocol for the review

The review follows the guidelines of the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) statement [22], its extension for abstracts and was not registered.

2.2 Search strategy

The authors conducted a systematic search of electronic database platforms of PubMed, Ovid, Cochrane and Web of Science based on PICOS framework as mentioned in the table number 1. The literatures available from January 2000 to May 2020 were evaluated using the Mesh terms like 'rapid maxillary/palatal expansion', 'computed tomography/tomographic scan/CT/CBCT', 'skeletal/bony/soft-tissues/periodontal changes' and 'retention/stability'. Additional manual searching of relevant articles in Google Scholar was conducted and shortlisted.

Table 1: PICOS description

Picos parameter	Description
Population	Clinical studies on patients with unilateral or bilateral posterior crossbite due to constricted maxillary arch with presence of mild crowding.
Intervention	Rapid maxillary expansion evaluated with computed tomographic scan.
Comparison	No treatment was undertaken.
Outcome	Changes in skeletal, dental, and soft-tissue parameters.
Study design	Prospective, comparative, retrospective, randomized controlled studies.

2.3 Criteria for selection

The selection criteria for the articles: (a) Young patients ranging from 6 to 18 years of age with constricted maxillary arch leading to unilateral or bilateral posterior cross bite and mild crowding (b) Studies that entailed clear description of the appliance used for the rapid maxillary expansion and its immediate skeletal, dental and soft-tissue after-effects with computed tomography scan (c) Original prospective, retrospective studies and randomized clinical trials (d) Studies with quantitative data available for various parameters of RME with the help of computed tomographic scan.

The exclusion criteria were: (a) Presence of any congenital anomalies or syndromes (b) Samples with surgically assisted rapid maxillary expansion (c) Utilizing any extra-oral appliances like facemask, headgear or any functional appliances.

All the studies matching the Mesh from the mentioned databases published during last two decades are included. Accordingly, the databases were searched electronically and the most appropriate literatures were selected for the review. Shortlisting of the literatures were done after going through the whole article by the authors. In case of any discrepancy, it was resolved through discussions until consensus was attained.

2.4 Data collection

Both the authors were involved in the data collection process. Screening of the title followed by the abstract was performed blinded. The primary objective of gathering data was to sort the articles which contained computed tomography studies related to any kind of changes observed after the procedure of rapid maxillary expansion. Information related to study design, sample size, selection criteria and the appliance used for RME were noted along with details of expansion protocol, activation frequency, amount of activation and duration of retention were analyzed.

The final decision on selection was done by reading the complete articles individually and consensus was reached through inter-rater discussion of the literatures (Cohen's κ = 0.844). As per the PRISMA statement, the defects in conduction or the design of the study can produce bias. Hence the methodological quality has been assessed for enhancing the strength of the evidences provided though no specific method has been applied [23].

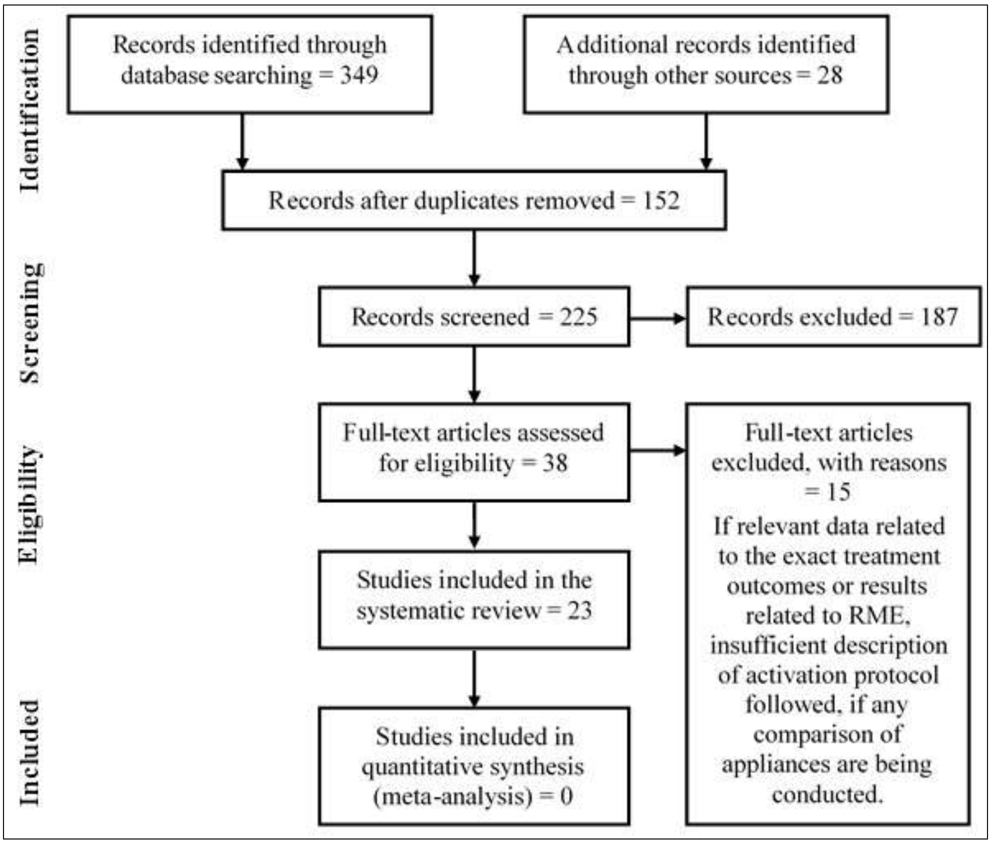

Fig. 1: Flowchart representing different phases of the systematic review

3. Results
3.1 Study selection
The initial electronic search yielded 349 articles and 28 additional articles were retrieved through manual searching. After removing 152 duplicate articles, further 187 articles were excluded after careful application of the selection criteria. The articles which were not clinical or no strict activation protocol followed too were excluded from the review. Finally 23 studies were included based on the inclusion criteria out of which 19 were prospective, 2 were controlled, 1 were retrospective study and 1 was comparative study.

3.2 Study characteristics
The age range for the patients in this study was 6 years to 18 years with average of 10.7 years. Due to inclusion of variety of parameters for the systematic review, there was minute variation in the selection criteria. However, all the patients included in the individual studies used CT scan on non-syndromic patients with transverse maxillary deficiency. Majority of the studies included Hyrax-type [33, 37-38, 46, 50, 58-59, 64], Haas-type [32, 34, 43, 62-63] and butterfly-shaped [28, 29, 31] expansion devices. With the varied needs of individual patients, duration of activation too varied accordingly. The expansion protocol, and retention schemes were well defined in all the included studies.

Table 2: Studies at a glance

Author/Year	Study objective	Sample design	Sample size & mean age	Significant observations
Franchi *et al.* [28] 2010	To determine the treatment and the post-treatment changes on the mid-palatal suture density from RME.	Prospective	17 children (11.2 years)	▪ Maximum opening of the mid-palatal suture in the anterior region which re-organized 6 months in to the retention.
Lione *et al.* [29] 2012	To evaluate RME effects on palatal using standardized circles which are not influenced by position of the tooth or by the alveolar and skeletal morphology.	Prospective	17 children (11.2 years)	▪ Increase in the palatal area, both transverse and sagittal due to the opening of the mid-palatal suture with alveolar arch tipping.
Lione *et al.* [31] 2013	To investigate post-RME and post-retention changes in the mid-palatal and transverse sutures.	Prospective	17 subjects (11.2 years)	▪ Overall reduction of radio-density all along the mid-palatal suture with re-organization noticed after 6 months in to the retention.
Filho *et al.* [32] 2006	To evaluate the post retention ossification status of the mid-palatal sutures in children.	Prospective	17 children (8 years 2 months)	▪ Mild gap at the anterior suture margins after retention. ▪ Ossification of suture took place after 8 – 9 months in to the retention.
Podesser *et al.* [33] 2007	To quantify and evaluate the skeletal and dentoalveolar changes with RME.	Prospective	9 children (8 years 1 month)	▪ Overall increase in mid-palatal suture width, intermolar and canine width, maxillary alveolar width, nasal width and tipping of molars. ▪ Alveolar and intermolar width changes was more than skeletal components.
Baratieri *et al.*	To determine the transverse effects of	Prospective,	30 subjects	▪ Increase in maxillary first molar width,

[34] 2014	RME on the nasomaxillary complex and its stability after one year.	Controlled	(Male: 9 years 4 months; Female: 9 year 7 months)	maxillary alveolar width, basal width, palatal alveolar width, nasal cavity and base width.
Garrett *et al*. [35] 2008	To evaluate skeletal effects of RME.	Prospective	30 patients (13.8 ± 1.7 years)	▪ Skeletal expansion accounted for 55% of total expansion at the maxillary first premolar area which gradually decreased posteriorly. veolar bending and tipping was noticed. ▪ Increase in nasal width and maxillary sinus width.
Ghoneima *et al*. [37] 2010	To investigate the changes related to the craniomaxillary complex and dental arches after RME.	Prospective	20 patients (12.3 ± 1.9 years)	▪ Increase in alveolar width, intermolar width, intercanine width, maxillary base width, and molar angulation.
Phatouros *et al*. [38] 2008	To determine the changes in palate with RME in early mixed dentition stage.	Retrospective	43 children (9 years 1 month)	▪ Increase in inter-dental width across canine, deciduous and permanent first molar. ▪ Increase in the cross-sectional area across permanent first molars.
Weissheimer *et al*. [39] 2011	To evaluate and compare immediate effects of rapid maxillary expansion with Haas-type and hyrax expanders.	Prospective, Comparative	33 patients (10.7 years)	▪ Maximum change in inter-molar width followed by change in the first molar angulation. ▪ Change in posterior width at alveolar crest level was anterior width at mid-alveolar level. ▪ Dental change > skeletal change.
Ballanti *et al*. [40] 2010	To determine the treatment and the post-retention changes of RME on maxillary central incisors, mid-palatal suture and nasal cavity.	Prospective	17 children (11.2 years)	▪ Increase in inter-incisal crown and apex width with divergence of roots more than the crown. ▪ Significant expansion of nasal cavity especially in the anterior region.
Baratieri *et al*. [43] 2013	To compare RME related orthopedic changes casting its effect on pulp chamber with a controlled group.	Prospective, Controlled	30 children (Male: 9 years 7 months; Female: 9 years 4 months)	▪ The pulp chamber dimension of maxillary central incisors progressively reduced towards the CEJ.
Ghoneima *et al*. [46] 2011	To determine the quantitative changes in the cranial and circummaxillary suture after rapid maxillary expansion.	Prospective	20 patients (12.3 ± 1.9 years)	▪ Greatest increase in the inter-maxillary suture at incisor level. ▪ Changes in circummaxillary sutures: Internasal > Nasomaxillary > Frontonasal >Frontomaxillary sutures.
Leonardi *et al*. [47] 2011	Changes in the circummaxillary sutures after RME.	Prospective	8 patients (9.8 ± 1.8 years)	▪ Internasal and nasomaxillary suture showed maximum separation after active expansion.
Kim *et al*. [50] 2012	To evaluate the soft-tissue changes with RME.	Prospective	23 patients (12.3 ± 2.6 years)	▪ Significant increase in the inter-occular distance, inter-zygion distance, alar width of the nose, transverse increase in the lip and lower mid-face, subnasale moved anteriorly and vertical length of the upper lip. ▪ Anterior repositioning of the bridge of the nose was noted in few patients. ▪ Soft-tissues over infra-orbital foramen moved anteriorly. ▪ Decrease in the upper and lower lip thickness.
Altorkat *et al*. [51] 2016	To study the immediate effects of RME on nasomaxillary soft-tissue.	Prospective	14 patients (12.6 ± 1.8 years)	▪ Significant increase in nasal base width and nasal tip displacement angle.
Garib *et al*. [54] 2006	To analyze the periodontal effects of RME done with Haas and Hyrax-type expander.	Prospective	8 patients (Haas Group = 12.4 years; Hyrax Group = 12.6 years)	▪ Buccal bone plate thickness of anchored teeth reduced in both the groups. ▪ Thickening of lingual bone plate and increase in the buccal alveolar crest level was noticed in the first premolar area of the Haas group. ▪ Hyrax group too showed increase in the buccal alveolar crest level of first premolar along with mesial, central and distal areas of first molar. ▪ Larger bone dehiscence was produced with Hyrax expander at the first premolar area.
Chang *et al*. [58] 2013	Changes with RME on upper airway dimensions and transverse width.	Prospective	14 patients (12.9 years)	▪ Effect of RME more in the upper airway and fades as we go down.
Zeng *et al*. [59] 2013	To investigate upper airway changes post RME.	Prospective	16 children (12.73 ± 1.73 years)	▪ Increase in lower nasal volume, nasal floor width and nasal lateral width.
Görgülü *et al*. [61] 2011	Evaluating RME effects on volume of the nasal cavity.	Prospective	15 patients (13.86 ± 1.4 years)	▪ Increase in the volume of the nasal cavity which decreased towards the apical and posterior region.
Caprioglio *et al*. [62] 2014	To investigate RME effects on airway in terms of volume.	Prospective	14 patients (7.1 ± 0.6 years)	▪ Increase in inter-palatal foramen distance, O_2 saturation, apnea-hypopnea index and total airway.
Fastuca *et al*. [63] 2015	To study of the effect of RME on airway volumes.	Prospective	22 patients (8.3 ± 0.9 years)	▪ Total airway volume, O_2 saturation, apnea-hypopnea index and the cross-sectional area

				immediately posterior to the hard palate increased.
Almuzian *et al*. [64] 2018	To assess the immediate three-dimensional and volumetric effects of RME in the upper nasopharyngeal airway.	Prospective	17 subjects (12.6 ± 1.8 years)	▪ Significant change in the intermolar alveolar crest width. ▪ Volume of lower nasal cavity increased which was insignificant but the change was 5 times greater in the males.

4. Discussion

RME is a widely practiced technique which has a tendency to attain transverse and sagittal dimensional effects. Thorough documentation of these changes is still a challenge to an orthodontist. The reproduction of skeletal, dental, and soft-tissues with 3-dimensional imaging using CT scan is considered as a superior diagnostic approach to quantify and compare the pre-treatment and post-treatment outcomes. It overcomes image distortion and provides three-dimensional representation in a single scan with high resolution which is easier to interpret. It also eliminates the chances of structural superimpositions which is common with conventional radiographs which at times lead to inaccurate diagnosis. It is evident that the CT scan proves to be much better diagnostic tool as compared to other conventional radiographs, yet radiation exposure to patients with CT scan is relatively high. All precautions must be undertaken to minimize patient's exposure to the radiation based on the principle of ALARA (As Low as Reasonably Achievable). Cone-Beam Computed Tomography (CBCT) is more advanced imaging techniques with lower radiation emission as compared to the conventional CT. Radiation dose in CBCT can be further decreased by addition of supplementary collimator devices. As the overall dose of the 3-dimensional imaging systems remains high, using the same for every orthodontic case may not be justified. Other limitations which prevent the use of dental CBCT in many countries are expensive for the patients as well the operating costs are high for the practitioners.

Clinically, the age factor becomes an important point to consider when it comes to RME. Usually the rate for successful distraction of the mid-palatal suture diminishes with age. Suitable timing for successful RME was mentioned in the study of Angelieri *et al.* [24]. Forty years of investigation at the University of Michigan concluded that the ideal time for RME is during the pre-pubertal phase and at the post-pubertal period [25].

4.1 Skeletal and dental changes

Midpalatal suture is an important anatomical landmark located at a junction of two palatal shelves. Gradual ossification of the suture gives sufficient window period to expand it within the physiological limits which in turn allows to attain a harmonious upper and lower jaw relationship. RME, by generating a force in the range of 15 – 50 Newtons [26] safely separates the mid-palatal suture, thereby increasing the arch perimeter, the posterior arch width and alteration in the palatal morphology. On a broader perspective, the outcomes of RME can be categorized as direct and indirect effects. The main direct skeletal change includes opening of the mid-palatal suture in the range of 1.15 mm to 3.01 mm with maximum opening in the anterior sutural region and least in the posterior sutural region [27]. Studies have shown a reduction in the sutural density during the active phase of expansion [28] with increase in palatal surface area [29-30]. However in the retention phase, the mid-palatal suture gets reorganized, with improvement in the density. The densitometric analysis of Lione *et al.* [31] observed pre-expansion mid-palatal suture density from 563 HU to 833 HU with least in the anterior due to the presence of the nasopalatine duct and maximum in the posterior region. RME reduced the density by 70 – 80% along the suture. 6-month post-retention scan showed reorganization of the suture and improvement in the density relatively closer to the pre-expansion level. While the transverse suture had a pre-expansion homogenous density from 870 HU to 906 HU, it decreased considerably during expansion. The density improved post-retention but was significantly smaller than the pre-treatment values. This might suggest that the transverse suture would take more time to reorganize as compared to the mid-palatal suture. The overall time taken for complete re-ossification of the mid-palatal suture after retention was usually 8 – 9 months [32]. Other direct effects includes increase in the maxillary alveolar width and maxillary base width [37]. The studies conducted by Podesser [33], Baratieri [34], Garrett [35], and Ballanti [36] also favored maxillary alveolar and base width changes up to 5.25mm and 5mm, respectively. The most peculiar direct effect on dental units includes formation of maxillary midline diastema. Closure of the midline diastema between the maxillary central incisors occurs during the phase of retention by mesial tipping of the crown. Reduction in the angulation of the central incisors and increase in the distance between the apexes (3.4 ± 0.4 mm) was significant during RME. Posteriorly, the transverse dental changes occurred mostly at the molar crowns (6.3 ± 2.1 mm) followed by the molar apices (2.7 ± 1.9 mm). Observations suggest simultaneous increase in the maxillary premolar and canine widths (3.3 ± 0.9 mm) due to buccal tipping during the expansion process but the magnitude was less as compared to that of molar. Interdental increase in width between maxillary first permanent molars, deciduous first molar and canine has also been reported by Phatouros *et al.* [38].

Indirect effects include significant increase in mandibular first inter-molar width and mandibular inter-canine width, 1.7 ± 1.8 mm and 0.6 ± 0.9 mm, respectively. Other parameters which showed significant increase between the phase of active expansion and retention was bi-condylar width and bi-maxillo-mandibular width. Comparison between the magnitude of skeletal and dental effects becomes imperative in any study related to RME. The comparative randomized clinical trial by Weissheimer at al. [39] concluded that pure skeletal expansion was larger than the actual dental expansion. The separation of the mid-palatal suture accounted for 50% of the total expansion in the anterior region and 36% in the posterior region with hyrax appliance producing marginally greater skeletal effect. The separation of the maxillary halves was also noted in a parallel manner with significant amount of expansion in relation to nasal cavity [40].

Literatures [41-42] have reported iatrogenic pulpal reactions to orthodontic forces. Prospective controlled CT study by Baratieri *et al*. [43] observed progressive reduction of -0.32, -0.36 and -0.43 mm^2 in the pulpal dimension as it approached the cemento-enamel junction. A mild increase of 0.48 mm^2 was recorded on the middle section of the central incisor crown which might be attributed to the interference of secondary dentin deposition during mesial drifting of the roots to gain the original axial inclination.

4.2 Effects on circummaxillary sutures
The cranial and the circummaxillary sutures aid in articulation of the maxilla with skull bones. These sutures helps in unification, performs as shock absorbers against various forces, allows relative freedom of inter-bony movements and acts as growth sites [44-45]. Though, the sutures lie away from the site of expansion, significant changes have been observed during the phase of active expansion. A prospective study [46] showed significant increase in width of all cranial and circummaxillary sutures except frontozygomatic, pterygomaxillary, zygomaticomaxillary and zygomaticotemporal sutures. In the study, maximum changes were noted in the intermaxillary suture (1.7 $\pm$ 0.9 mm) and internasal sutures (0.6 $\pm$ 0.3 mm) followed by nasomaxillary sutures (0.4 $\pm$ 0.2 mm). Contrarily, Leonardi *et al.* [47] observed maximum opening in the nasomaxillary suture (0.46 mm) followed by internasal suture (0.387 mm). Significant amount of suture opening was also noticed with the zygomaticomaxillary (0.343 mm) and frontomaxillary suture (0.309 mm). Difference in the findings of the above mentioned studies might be due to the age difference in the samples selected. While the former study included patients with age ranging from 8 – 11.4 years, the later included subjects from 8 – 15 years of age. Fusion is mostly evident after 15 years of age while a great variability exist between the ages of 10 to 15 years in fusion of zygomaticomaxillary suture. Absence of fusion was noted in patients below 10 years of age [48] while majority occurred after 15 years. Further research is needed in relation to other circummaxillary sutures especially keeping the demographic factors, gender, age, and facial profile as point of interest.

4.3 Soft-tissues
Gradual changes in the overlying soft-tissues are observed with notable differences in the soft-tissue nasal base width at a ratio of 1:1 [49]. Kim [50] mentioned transverse widening of the mid-face based on the increase in distance between exocanthion and endocanthion of the right and left eye as 1.98 mm and 2.52 respectively. The right and left zygions also attained 1.98 mm of separation with subsequent increase of 1.79 mm in the width of the alar base of the nose. Other observation include mild anterior positioning of the soft-tissue nasion, the bridge of the nose, the soft-tissue subnasale and soft-tissue over the infra-orbital margins with decrease in the thickness of the upper and lower lips. Altorkat *et al.* [51] studied the effects of RME on nasomaxillary facial soft-tissue complex and concluded significant increase in the nasal base width (1.6 mm) and nasal tip displacement angle (3.4˚) while increase in nasal dorsum height, nasal tip protrusion, nasal tip angle and philtrum width were relatively insignificant. Minute decrease in naso-labial angle and reduced length of upper lip were also noted. Potential side effects of RME includes flattened nasal shape and development of dorsal hump [52] which might be due to the flattening of the nasal tip on expansion.

4.4 Periodontal effects
Forces generated by RME appliances are capable to dislocate the anchor teeth and cause hyalinization of the periodontal ligament [53]. The buccal bone plate thickness reduced when the RME device was anchored to the maxillary permanent first molar and this value was less when the same was done with the maxillary deciduous first molar. However, in the post expansion phase, the thickness of lingual bone plate increased. Garib *et al.* [54] observed that in the patients with thin buccal plates had greater chance of dehiscence in the buccal aspect of the anchored teeth. The CBCT study by Rosa *et al.* [55] observed apical migration of buccal alveolar bone crest of posterior anchored teeth following excessive buccal tooth movement.

4.5 Airway effects
Hard palate is in close proximity to the structures including the nasal and nasopharyngeal apparatus and minute change due to orthopedic expansion is well expected. The hypothesis of McDonald [56] and Warren [57] mentioned that the dysjunction at the mid-palatal suture anatomically and physiologically affect the nasal cavity. Chang *et al.* [58] measured the upper airway volume between the superior horizontal line of posterior nasal spine (PNS) and Basion (Ba) and inferior horizontal line passing through the most superior point of the epiglottis on the CT scan and observed an increase in the cross-sectional area between PNS – Ba by 59.6%. An enhancement of 16.6% was found in the retro-palatal airway, the area between PNS - Ba and horizontal plane crossing the most postero-inferior point of the soft-palate on the CT scan. Expansion of nasal cavity [59-60] and increase in nasal volume is also observed with RME [61]. Other effects include increase in total airway volume, oxygen concentration with improvement in apnea and hypopnea index [62-63]. Mild lowering of maxillary sinus volume [64] due to reshaping of the maxillary sinuses [65] or superior repositioning of the lateral structures of the naso-maxillary complex [66] has also been noticed. Izuka *et al*. [67] showed an increase in the nasopharyngeal volume and transition from mouth breathing to nasal breathing post RME.

5. Conclusion
Transverse dimension is a unique parameter which needs to be kept in mind while planning orthodontic treatment. Rapid maxillary expansion is a standard procedure with the ability to resolve multiple problems at the level of skeletal, dental and airway. It increases the palatal surface area by separating the midpalatal suture with more separation noted in the anterior region. Due to the separation, the midline diastema is observed which can be considered as a sign for skeletal expansion. Other dental changes included buccal tipping of maxillary canines, premolars and molars. Increase in width of circummaxillary sutures were too noted. Other notable changes observed were increase in nasal base width, nasal tip displacement angle, increase nasal and total air volume, improved oxygen concentration and reduction in buccal plate thickness.

Though numerous literatures are available on the benefits of RME, it is now evident that the exact benefits can be appreciated by using computed tomography. It produces high resolution images as compared to the conventional radiographs. Age, ideal appliance design and demographical related factors needs further study.

Overall, incorporation of rapid maxillary expansion in orthodontic practice is highly beneficial in terms of efficiency and treatment result. It provides a single method of dealing with myriad of problems through non-extraction of teeth.

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