ASDJ
AINSHAMS DENTAL JOURNAL

Print ISSN 1110-7642
Online ISSN 2735-5039

AIN SHAMS DENTAL JOURNAL
Official Publication of Ain Shams Dental School
December 2020 • Vol. XXIII

Modified Haas Expander for Relief of Crowding in Children A Randomized Controlled Trial

Mohamed Moustafa Hadhoud[1], Hamdy Hafez Elzahed[1], Ibrahim Mazen Negm[1] and Noha Hussien Abbas[1]

Abstract

Purpose: This study was conducted to evaluate the effect of rapid maxillary expansion using modified Haas appliance anchored on deciduous teeth in relief of maxillary crowding at the transition stage, monitoring the surrounding effects on dental, skeletal and soft tissues.

Materials and methods: Eighteen participants with maxillary anterior crowding at the transition stage with mean age (8.5 ±1.5years), were randomly allocated into two groups. Group (A)was composed of 10 consecutive transitional dentition patients treated with a modified Haas type rapid maxillary expansion appliance anchored on the maxillary primary molars and canines. Study models were made before RME (T1), at appliance removal (T2), 6 months after appliance
removal (T3) and 6 months later (T4), CBCT scans were taken for group (A) at T1 and T3. A control sample of 8 participants with maxillary anterior crowding who had no orthodontic treatment was categorized into group (B). Study models were made for the control group as well.

Results: There was a significant difference regarding intergroup and intragroup comparisons in the arch length discrepancy due to increase in the maxillary arch perimeter, intermolar width for second deciduous and first permanent molars, inter canine width. Also, from CBCT there were significant increase in amount of sutural expansion, inter jugale width and piriform aperture width.

Conclusion: From the results obtained from this study, it could be concluded that rapid maxillary expansion at the transition stage using modified Haas expander utilizing the deciduous teeth is effective in relieving early maxillary crowding.

Keywords: rapid maxillary expansion, deciduous dentition, modified Haas expander, crowding

[1] B.D.S (Ain Shams University 2010)
[1] Professor of orthodontic department, Faculty of Dentistry, Ain Shams University
[1] Assistant Professor of orhodontics, Faculty of Dentistry, Ain Shams University
[1] Assistant Professor of orhodontics, Faculty of Dentistry, Ain Shams University

Introduction

Crowding of the maxillary permanent incisors, is commonly observed during eruption of the permanent lateral incisors. The importance of the interceptive treatment in the early mixed dentition is to generate adequate space for the early alignment of the permanent upper central and lateral incisors prior to complete their full eruption. When crowding is limited to few millimeters, normal growth could provide adequate space, but when the palate is narrow and the crowding exceeds this amount, RPE could represent an effective procedure. (1,2)

The Haas appliance is a tooth-tissue-borne device, anchored to the first molars and premolars by bands and to the palatal vault by an acrylic body; these teeth become buccally inclined due to heavy forces exerted during active phase against them to open the mid-palatal suture also anchored teeth may suffer from exostosis, bone loss, gingival recession, pulp stones or rather root resorption and clinical evidence of periodontal damage has also been reported.(3)

Rapid Palatal Expansion (RPE) in the absence of posterior crossbite remains a questionable method for increasing upper arch perimeter and causing relief of the anterior crowding. (4,5)

Shifting to the digital era became a fact, orthodontics is no exception. Cone beam computed tomography technology was designed for imaging hard and soft tissues of the maxillofacial region with minimum distortion at a lower cost and with lower radiation emissions compared with conventional computed tomography. It allowed for more accurate orthodontic diagnosis as well as evaluation of treatment effect.

Implementing these two technologies to assess the maxillary expansion procedures allowed for better understanding of the effects of the expansion on growing patients.

Thus, this study has been dedicated to treat the maxillary crowding at young age with the modified Haas expander anchored to maxillary deciduous teeth; measuring the maximum crowding severity could be relieved, the effect of expansion on (skeletal, dental and soft tissues) and also the concurrent effect of maxillary expansion on the mandible will be monitored. Measurements done on casts using 3shape software, also other 3D measurements would obtain from CBCT scans analysis.

Materials and Methods

The experimental group A was composed of 10 transitional dentition participants (4 girls and 6 boys) demonstrating maxillary anterior crowding with no cross bite. Group A was treated with a modified Haas-type RME appliance modified to be anchored on the maxillary primary molars and canines (Figure 1). The average patient

age at the beginning of expansion was 8.5 years.
Study models were obtained at four observation periods: before RME (T1) at the end of expansion (T2) 6 months retention (T3) after 6 months later (T4), CBCT scans were taken to participants of group A at T1 and T3. All patients' parents were informed about the proposed treatment. All parents accepted and signed a consent form. The control group (B) consisted of 8 individuals seeking orthodontic treatment with maxillary anterior crowding who had received no orthodontic treatment. The control sample received Nance holding device for 13 months, Study models were taken for the control groups comparable with the treated participants at (T1) and (T4). Furthermore, In Group A all patients were fitted with expansion screws (Leone-SPA, Florence-Italy). The posterior arms of the screws were soldered to bands cemented on the second primary molars, and the anterior arms of the screw were micro-etched to the canines to aid in retention.

Patients were instructed to activate the appliance once daily according to the selected expansion protocol; each activation is a quarter turn (0.25 mm). The activation was terminated before the second deciduous molars would get into a scissors bite or in other words; the expansion was considered complete when the occlusal aspect of the maxillary palatal cusp of the second deciduous molars contacted the occlusal aspect of the buccal cusp of the mandibular second deciduous molars (figure 2).

Figure (1): Modified Haas appliance just before delivary.

The appliance was stabilized and kept in place for retention for 6 months; after removal of the expander, a fixed trans-palatal arch with anterior extended arms was placed within 48 hours. The TPA was left 6 months for retention.

The patients were recalled weekly during the expansion phase to monitor the amount of expansion and to check for any appliance adjustments, then monthly at the retention phase, but for the control group they were recalled every month from the beginning till the end of the study phase.

Measurements:

The following measurements were done on study casts digititally using 3Shape software (figure 3).

1) Palatal Depth: Linear measurement from the deepest point at the palate to a horizontal occlusal Plane connecting (molars cusp tips and

incisal edges) (only on maxillary casts)

2) Arch length: Linear measurement from gingival midline (between central incisors) till line connecting between mesio-buccal cusps of right and left first permanent molars (For both arches)
3) Arch Perimeter: Measuring total circumference of the arch by joining 4 lines; from mesial surface of right first permanent molar to cusp tip of right primary canine then from right primary canine to midline then again from midline to cusp tip of left primary canine and finally from cusp tip of left primary canine to mesial surface of left permanent first molar (For both arches) .
4) Inter Canine Width: Linear measurement between cusp tips of deciduous canines bilaterally (For both arches)
5) Inter second primary molar width: Linear measurement between Palatal gingival margins of second deciduous molars bilaterally (Measured from cervical margin at the end of palatal groove (For both arches)
6) Inter first permanent molar width: Linear measurement between palatal gingival margins of first permanent molars bilaterally (Measured from cervical margin at the end of the palatal groove (For both arches).

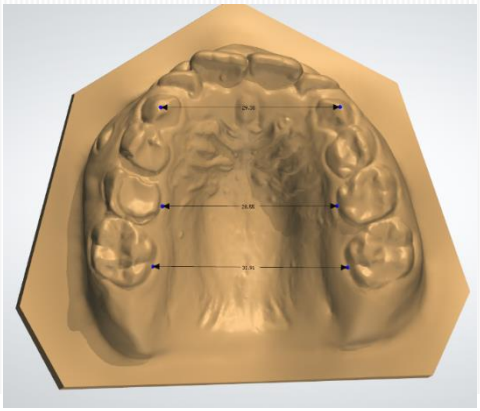

Figure (3); screenshot from 3Shape software

The following measurements were done on CBCT using DDS-pro software version 2.6.1, CBCT scans were taken by planmeca Promax 3D Mid Proface, Finland CBCT scanner, with values; FOV 18cm X 20cm, ultralow dose protocol (90KV, 8mA, time 9 sec, voxel size 400 micron):

1)Amount of sutural expansion, 2) Inter jugale width, 3) Piriform aperture width, 4) Buccal second deciduous molar inclination, 5) Inter first permanent molar apical width, 6) Alar base width, 7) Width of the mouth, 8) Anterior nasal spine to vertical reference plane, 9) Mandibular pogonion to vertical reference plane, 10) upper central incisor to vertical reference plane, 11) Soft tissue pogonion to vertical reference plane, 11) Angle of the mandible, 12) Mandibula second deciduous molar inclination, 13) Mandibular central incisor to vertical reference plane, 14) Maxillary central incisor inclination, 15) Upper lip to E.line, 16) subnasal to FH plane, 17)Soft tissue pogonion to FH plane, 18) Vertical palatal position, 19) Amount of maxillary second deciduous molar extrusion.

Results

There were significant difference when comparing T1 and T4 for group (A) in maxillary casts analysis. Arch perimeter increased by a mean of 3.62±2.19 mm, For the inter molar width significantly increased for second deciduous molar and first permanent molar by a mean of

(3.23±1.50 and 2.70±1.62 mm) respectively The inter deciduous canine width measurements showed significant increase by average of (2.58±1.42mm), while for group (B) arch perimeter increased by a mean of 1.98±1.53 mm, and for inter deciduous canine width an average increase of (0.55±1.18 mm) from T1 to T4 were found, an increase of (0.55±1.18 mm) from T1 to T4. No significant difference were found for arch length nor palatal depth. Mandibular casts analysis showed no statistically significant difference along the different follow up intervals.

CBCT analysis (figure 4)showed statistically significant increase in the skeletal measurements as the following; sutural expansion to be (1.27±0.12mm) at the upper central incisors and (1.04±0.12mm) at the first permanent molars, also at the inter jugale width by a mean of (1.60±1.00 mm), for the piriform aperture the increase was by a mean of by (0.76±0.75 mm).

Dental analysis showed an increase in the maxillary second deciduous molars inclination by about 5.91±7.43 and 2.32±4.09 degrees for the right and left second deciduous molars, respectively. Maxillary central incisor also found an increase in the labial inclination by a mean of 4.17±3.88 degrees. Maxillary second deciduous molar extrusion increased at both right and left sides by a mean of 1.14±2.29 and 1.41±0.60 mm respectively.

Table (1): Mean, Standard deviation (SD) values of maxillary casts measurements change in mm.

Maxillary cast measurements	Follow-up	Group (A)	Group (B)	p-value
Arch Length	T1-T2	0.00±0.82		——
	T2-T3	0.08±1.15		——
	T3-T4	0.30±0.59		——
	T1-T4	0.38±0.73	0.33±0.94	٠.209ns
Arch Perimeter	T1-T2	3.63±1.87	——	——
	T2-T3	0.35±1.20	——	——
	T3-T4	-0.36±1.42	——	——
	T1-T4	3.62±2.19	1.98±1.53	٠.093ns
Inter deciduous canine width	T1-T2	2.76±1.36	——	——
	T2-T3	0.04±0.84	——	——
	T3-T4	-0.22±0.98	——	——
	T1-T4	2.58±1.42	0.55±1.18	0.011*
Inter first permanent molar width	T1-T2	2.88±1.61	——	——
	T2-T3	0.26±0.92	——	——
	T3-T4	0.10±0.65	——	——
	T1-T4	2.70±1.50	0.41±0.46	<٠.001*
Inter second deciduous molar width	T1-T2	2.90±1.62	——	——
	T2-T3	0.38±1.53	——	——
	T3-T4	0.16±0.65	——	——
	T1-T4	3.23±1.50	0.48±1.03	٠.020*
Palatal Depth	T1-T2	-0.11±0.46	——	——
	T2-T3	0.06±0.53	——	——
	T3-T4	0.40±0.62	——	——
	T1-T4	0.35±0.70	0.10±0.40	٠.384ns

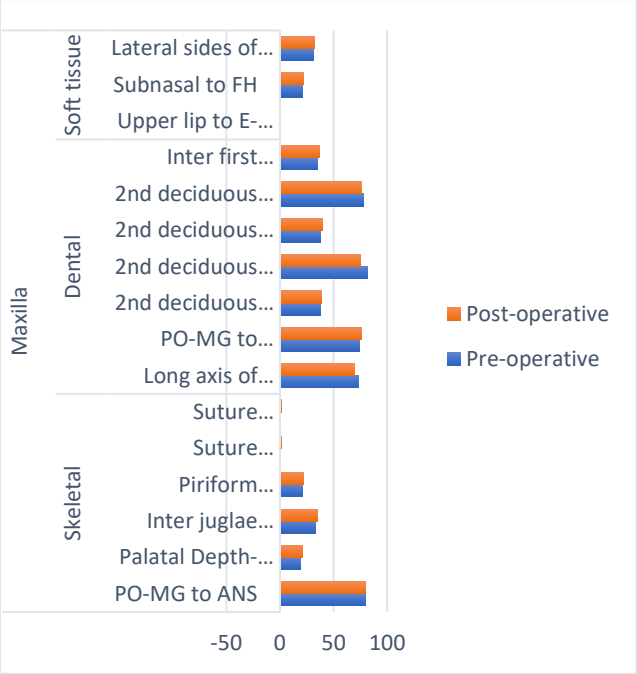

Figure (4): Bar chart showing average values of maxillary arch CBCT measurements in group (A).

Discussion

The protocol of expanding the maxillary arch anchoring on to the deciduous teeth, during the transition stage, was used as a treatment method during the last few years by different orthodontists like; **Mutinelli S, Cozzani M, Da Filho G, Rosa M** for various purposes like: correction of posterior cross bite, class III correction or for obtaining of spaces for eruption of laterals. (6,7,8,9,10) Accordingly, we decided to use this protocol in order to relief the crowding during mixed dentition, in order to correct malalignment, gain space in the constricted arch and facilitate the eruption of the permanent teeth. Another benefit is to protect the permanent teeth from the deleterious effects when used as anchoring units for an expander. Such effects are: buccal inclination, bone loss, exostosis, pulpal stones, root resorption and gingival recession. (10,11)

The selected patients participating in both groups were 7-10 years of age, which matches numerous similar studies such as **Marco Rosa et al** in 2016 where the mean age was 8 years and 10 months. **Marco Rosa et al** proposed that the best timing for expansion is during the early mixed dentition phase, prior to the eruption of the upper permanent lateral incisors and after the permanent molars have fully erupted and coupled in occlusion. (10)

The age range of the current study offers two benefits; the first is the ability to treat the patients included in the control group after finishing the study, since there will be adequate time to treat them, either by the same appliance or with any other way of treatment. The second is to benefit the most from the maxillary second deciduous molars and canines before their roots get resorbed or become loose. The early clinical sign of this orthopedic effect was the appearance of a diastema between the upper central incisors. This is sign is quickly diminished due to recoil of transseptal fibers. That was formerly displayed by **Da Silva Filho et al** as well as **V.Grassia et al.** (12,13)

Space for storing problems, transferability, storing cost, reproduction, communication, risk of breakage and retrieval are potential disadvantages of plaster models that were illustrated by **Leifert** in his comparison of space analysis evaluations with digital models and plaster dental casts.(14) Study done

by **Torassian G et al** comparing digital models vs plaster models using alginate and alginate substitute materials showed the advantage of digital models in eliminating the problems of storage and of model breakage (15).

It is also worth mentioning that despite the risk from imaging in our dental practice in general is small for an individual, when multiplied by the large population of patients who are exposed to diagnostic imaging, radiation risk becomes a significant public health issue. Therefore, strategies to reduce patient dose, keeping doses "as low as reasonably acceptable" (ALARA) are desirable. An average reduction in dose of 77% was achieved using ULD protocols when compared with standard protocols in which this dose reduction was significant. No statistical reduction in image quality between ULD and standard protocols was seen. Accordingly, we decided to take CBCT images using ULD technique by Planmeca with its effective dosage for children from 10-36 μSv.(16)

The results for the arch perimeter were relatively lower than that obtained by **Di Ventura A et al**, where the arch perimeter of the non-crossbite group increased by a mean of (3.0 mm) from pre-expansion till after end-of-retention phase, alsoshowed an increase in the inter deciduous canine width of (+3.63 mm ± 1.52 mm) from the start of expansion till the appliance removal after 1 year, using the 3Shape software that was used in the current study (17)

William C measured the inter second deciduous molar width before and after expansion, following a similar protocol to what was used in the current study. a significant increase by a mean of (4.2 ± 1.5 mm). (18) All measurements were made using a sliding Vernier caliper with sharpened points unlike the digital software that has been used in the present study.

Roberta Lione et al reported the sutural expansion to be (3.01 mm) at the upper incisors, (1.15 mm) at the first permanent molars. (19) **Ghoneima et al** found the suture opening to range between (1.6 ± 0.8 mm) at the upper incisors, (1.5 ± 0.8 mm) at the first permanent molars.(20)

This difference could be attributed to the different appliance used regarding **Roberta Lione et al's** study who used hyrax expander. And attributed to different rate of appliance activation that was used in our study regarding **Ghoneima et al 's study**. At our rate of appliance activation, enough time was allowed for the suture to fill in bone. Thus, a wide suture opening was not expected to show on the radiographs. (4)

Doruk et al compared the effect of the fan-type acrylic- fully bonded tooth-and-tissue-borne (RME) appliance with an acrylic fully bonded tooth-and-tissue-borne RME appliance on growing patients. Their measurements of the inter jugale width was found to be increased for both appliances by (0.29 and 0.41 mm) respectively. (21) However, the value obtained in our study is relatively

higher than that found in **Cenk Doruk's** study. The discrepancy could be due to the difference in the mean age of the participants, which was (12.4) while the current study was (8.5).

Rosamaria Fastuca et al, where the mean increase of the nasal floor width at the modified has expander group was (2.90 mm). (22)

Jessica L. Woller and **Ki Beom Kim's** methods to construct a sagittal vertical plane has inspired us during this study, by using the mid-dorsum of the foramen magnum as a 3D landmark. (23) For the current study, we have used a reference plane from the most anterior surface of foramen magnum with both right and left porion landmarks. These points have shown a high intra-reliability when located using 3D images. That method allows an adequate way to analyze the anterior-posterior differences on 3D images while measuring the vertical plane using those previously stated pints as reference.

Conclusion

Bearing in mind the limitations of this study, the following conclusions were drawn:

- Modified Haas appliance is effective in the treatment of early maxillary crowding at the transition stage.
- Anchoring on deciduous teeth gain the benefit of protecting the permanent teeth from the deleterious effects accompanying maxillary expansion.
- CBCT is an accurate advanced tool for 3D evaluation of maxillary expansion effects.
- Mandibular concurrent expansion to the maxillary expansion has no significant results, and need further researches.

References

1. Little RM. The irregularity index: a quantitative score of mandibular anterior alignment. *Am J Orthod*. 1975;68(5):554-563.
2. Bernabé E, Flores-mir C. Estimating arch length discrepancy through Little ' s Irregularity Index for epidemiological use. *Eur J Orthod*. 2006;28(April):269-273. doi:10.1093/ejo/cji112
3. Andrucioli MCD, Matsumoto MAN. Transverse maxillary deficiency: Treatment alternatives in face of early skeletal maturation. *Dental Press J Orthod*. 2020;25(1):70-79. doi:10.1590/2177-6709.25.1.070-079.bbo
4. Proffit W. *Contemporary Orthodontics*. 6th ed.; 2018.
5. Al BT et. Treatment and posttreatment craniofacial changes after rapid maxillary expansion and facemask therapy. *Am J Orthod Dentofac Orthop*. 2000;118(4):404-413.
6. Rosa M, Lucchi P, Manti G, Caprioglio A. Rapid Palatal Expansion in the absence of posterior cross-bite to intercept maxillary incisor crowding in the mixed dentition: A CBCT evaluation of spontaneous changes of untouched permanent molars. *Eur J Paediatr Dent*. 2016;17(4):286-294.
7. Cozzani M, Rosa M, Cozzani P, Siciliani G. Deciduous dentition-anchored rapid maxillary expansion in crossbite and non-crossbite mixed dentition patients: reaction of the permanent first molar. *Prog Orthod*. 2003;4(September 2015):15-22. doi:10.1034/j.1600-9975.2002.02034.x
8. da Silva Filho OG, do Prado Montes LA, Torelly LF. Rapid maxillary expansion in the deciduous and mixed dentition evaluated through posteroanterior cephalometric analysis. *Am J Orthod Dentofac Orthop*. 1995;107(3):268-275. doi:10.1016/S0889-5406(95)70142-7

9. Mutinelli S, Manfredi M, Guiducci A, Denotti G, Cozzani M. Anchorage onto deciduous teeth: effectiveness of early rapid maxillary expansion in increasing dental arch dimension and improving anterior crowding. *Prog Orthod*. 2015;16(1):1-7. doi:10.1186/s40510-015-0093-x
10. Al MS et. Dental arch changes following rapid maxillary expansion. *Eur J orthod*. 2008;30(5):469-476.
11. Rosa M, Lucchi P, Mariani L, Caprioglio A. Spontaneous correction of anterior crossbite by RPE anchored on deciduous teeth in the early mixed dentition. *Eur J Paediatr Dent*. 2012;13(3):176-180.
12. da Silva Filho OG, do Prado Montes LA, Torelly LF. Rapid maxillary expansion in the deciduous and mixed dentition evaluated through posteroanterior cephalometric analysis. *Am J Orthod Dentofac Orthop*. 1995;107(3):268-275. doi:10.1016/S0889-5406(95)70142-7
13. Grassia V, D'Apuzzo F, Ferrulli VE, Matarese G, Femiano F, Perillo L. Dento-skeletal effects of mixed palatal expansion evaluated by postero-anterior cephalometric analysis. *Eur J Paediatr Dent*. 2014;15(1):59-62.
14. Michael F Leifert 1, Melvyn M Leifert, Stella S Efstratiadis TJC. Comparison of space analysis evaluations with digital models and plaster dental casts. *Am J Orthod Dentofac Orthop*. 2009;136(1):16.e1-16.e4.
15. Torassian G, Kau CH, English JD, Powers J, Bussa HI, Salas-Lopez AM CJ. . Digital models vs plaster models using alginate and alginate substitute materials. Angle Orthod, 2010; 80: 662–669. *Angle Orthod*. 2010;80(4):662-669.
16. Ludlow JB, Koivisto J. Dosimetry of Orthodontic Diagnostic FOVs Using Low Dose CBCT protocol, IADR 2015 conference. *IADR 2015 -conference*. 2015;(March):0-1.
17. Lanteri V, Farronato G. Three-dimensional evaluation of rapid maxillary expansion anchored to primary molars : direct effects on maxillary arch and spontaneous mandibular response. *Eur J Paediatr Dent*. 2019;20(1):38-42. doi:10.23804/ejpd.2019.20.01.08
18. Berlocher WC, Mueller BH, Tinanoff N. The effect of maxillary palatal expansion on the primary dental arch circumference. *Pediatr Dent*. 1980;2(1):27-30.
19. Lione R, Ballanti F, Franchi L, Baccetti T, Cozza P. Treatment and posttreatment skeletal effects of rapid maxillary expansion studied with low-dose computed tomography in growing subjects. *Am J Orthod Dentofac Orthop*. 2008;134(3):389-392. doi:10.1016/j.ajodo.2008.05.011
20. Ghoneima A, Abdel-Fattah E, Hartsfield J, El-Bedwehi A, Kamel A, Kula K. Effects of rapid maxillary expansion on the cranial and circummaxillary sutures. *Am J Orthod Dentofac Orthop*. 2011;140(4):510-519. doi:10.1016/j.ajodo.2010.10.024
21. Doruk C, Bicakci AA, Basciftci FA, Agar U, Babacan H. A comparison of the effects of rapid maxillary expansion and fan-type rapid maxillary expansion on dentofacial structures. *Angle Orthod*. 2004;74(2):184-194. doi:10.1043/0003-3219(2004)074<0184:ACOTEO>2.0.CO;2
22. Fastuca R, Lorusso P, Lagravère MO, et al. Digital evaluation of nasal changes induced by rapid maxillary expansion with different anchorage and appliance design. *BMC Oral Health*. 2017. doi:10.1186/s12903-017-0404-3
23. Woller JL, Kim KB, Behrents RG, Buschang PH. An assessment of the maxilla after rapid maxillary expansion using cone beam computed tomography in growing children. *Dental Press J Orthod*. 2014;19(1):26-35. doi:10.1590/2176-9451.19.1.026-035.oar21.

ASDJ
Ain Shams Dental Journal