

Differential Rapid Maxillary Expansion – A Narrative Review

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ABSTRACT

*Maxillary transverse deficiency usually requires expansion of the palate by a combination of orthopedic and orthodontic tooth movement. Expansion of the maxilla and the maxillary dentition can be achieved by various ways. The skeletal and dental pattern influences the choice of expansion appliance and the type of expansion chosen will significantly facilitate the overall goals of treatment. Rapid maxillary expansion entails the use of heavy and continuous forces that are transmitted to the maxilla over a short period of time, which inadvertently produces an immediate and an effective increase of the maxilla in the transverse dimension. This expansion can be either produced symmetrically such that the arch expands uniformly, or differentially, where one section of the arch expands more than the other. This article aims at throwing light on differential rapid maxillary expansion, the appliances that produce it and its advantages over the other rapid maxillary expanders. **KEYWORDS:** Maxillary transverse deficiency, rapid maxillary expansion, differential expansion, expander with differential opening*

INTRODUCTION

Maxillary transverse deficiency is one of the most common skeletal deformities of the craniofacial skeleton.¹ Expanders for treating maxillary transverse deficiency have been used for over a century. There are four expansion treatment modalities that are used, namely rapid maxillary expansion (RME), slow maxillary expansion (SME), surgically assisted rapid palatal expansion (SARPE) and mini-implant assisted rapid palatal expansion (MARPE) with each having their own indications, contraindications, advantages and disadvantages. RME was first introduced by Emerson Angel in 1860.² RME is purported to produce minimum dental movement (tipping) and maximum skeletal movement.³ It uses heavy and continuous forces that are transmitted to the maxilla over a short period of time, which gradually splits the midpalatal suture producing an immediate increase of maxillary transverse width. Expansion can be achieved by two ways: (i) Expanders that achieve symmetrical arch widening, so that the intermolar and intercanine widths are increased by the same amount (ii) Expanders that produce differential expansion, with one section of the arch widening more than the other.⁴

NEED FOR DIFFERENTIAL EXPANSION

Conventional RME expanders split the midpalatal suture and increase maxillary arch width and arch perimeter with a parallel-opening screw, that is centrally positioned in the palate. This produces proportionate increase in maxillary arch width at the intercanine and intermolar regions.⁵ There are some characteristics of crossbite in complete clefts of the lip and palate that require a different approach. In the canine region, the medial displacement of the maxillary segment is typically much more severe than in the molar region with the molars being well positioned in the correct lateral relationship. Vertical growth is also often incomplete, which is worse in the canine region immediately behind the cleft. Therefore, a greater need to generate differential expansion more so by expanding the upper arch in the canine region with hardly any expansion in the molar region was opined by a few authors.^{4,6} It has been reported that one third of patients with maxillary constriction have a greater transverse deficiency in the intercanine region than in the intermolar region.⁷ In such cases, conventional RME expanders would produce overexpansion in the molar region too to correct the transverse deficiency in the intercanine region because the screws have a parallel opening. This could

cause undesirable effects due to a significant decrease in thickness of the buccal alveolar bone plate with an increased risk of bone dehiscence and gingival recession.^{8,9} Previous longitudinal studies on the long-term stability of conventional RME showed greater relapse of the intercanine widths than the interpremolar and intermolar widths.^{10,11} This showed the need for differential expansion with greater expansion at the intercanine region than at the intermolar region. A greater overcorrection in intercanine distance is also recommended to improve the intercanine expansion net gain.

EXPANDERS WITH DIFFERENTIAL OPENING

A number of differential expanders have been developed over the years. Initially, a screw and a hinge incorporated in a removable appliance was used. This had the general problems associated with removable appliances, namely desirable retention for effective rapid expansion. Also, it had very limited range of action which could only correct fairly mild discrepancies. In 1967, Broadway described an appliance which utilized splints and a hinged acrylic plate with a screw that produced differential expansion.¹² The disadvantage of this appliance was that the palatal covering produced oral hygiene problems as it was not removable by the patient for cleansing.

Keeping the previous shortcomings in mind the following qualities were considered as the main criteria in the designing of the expanders with differential opening.

- 1) It should be capable of producing expansion more in the canine region than at the molar region, by rotation of the whole segments.
- 2) It should be capable of producing rapid expansion, in order to decrease the treatment time.
- 3) It should be capable of a large range of action to be able to treat most severe discrepancies.
- 4) It should be readily maintained by the patient, without being detrimental to oral hygienic measures.

An appliance described by Foster and Chinn¹³ in 1977 satisfied all the criteria listed above. However, the production of differential expansion resulted in some widening at the molar regions, which though undesirable was unavoidable. Expansion of the intermolar width achieved was 50 per cent of the expansion achieved in the intercanine width. In order to overcome this problem of molar expansion, a modification of this appliance with an incorporation of a palatal bar was described by Devenish et al.⁴ In 1996, Schellino et al¹⁴ designed a spider screw named "Ragno" which produced differential expansion by allowing "fan opening." In 1999, Levrini and Filippi¹⁵ used the Ragno screw to successfully treat a six-year-old male with bilateral cleft lip and palate by bringing about expansion mainly at the anterior region. This brought the fan-shaped expander back into the limelight. Recently, a novel rapid maxillary expander was proposed by Garib et al¹⁶ in 2014 called the expander with differential opening (EDO). The EDO had 2 parallel-opening screws, 1 anteriorly positioned in the palate and the other one more posteriorly positioned. Different amounts of activation in the anterior and posterior expansion screws determined a trapezoid-shaped opening of the appliance diverging towards the anterior. Thus the appliance allowed the clinician to control the amount of expansion in the intercanine and intermolar regions with the help of two separate screws. The advantage of the EDO over a fan-shaped expander was that the EDO with its two screws enabled individualised expansion at the intercanine and intermolar region whereas the fan-shaped expander with a single screw anteriorly and a hinge positioned posteriorly was not that effective in the production of differential expansion. In cleft patients, the EDO was successful in producing an ideal archform when compared to the other expanders. It also helped prevent an overexpansion at the intermolar region with its associated deleterious consequences.

COMPARISON WITH CONVENTIONAL RME

The conventional RME has a parallel-opening screw positioned centrally in the palate to bring about symmetric expansion. Differential expanders on the other hand aim at achieving greater expansion in the anterior region. Various studies have been conducted to compare the effects of conventional and differential RME devices. A study by Corekci et al¹⁷ compared the effects of rapid maxillary expansion and fan-type rapid maxillary expansion in early mixed dentition. In both groups the maxilla moved downward and forward. The nasal cavity and maxillary widths were expanded more in the RME group and there was significant proclination of the upper incisors in the fan-type RME group. The expansion of intercanine width was similar in both groups, but the expansion of intermolar width was significantly greater in the conventional RME group. Doruk et al¹⁸ conducted a study to compare the sagittal, vertical

and transverse effects of RME and fan-type RME on dentofacial structures. The fan-type RME appliance separated the midpalatal suture like the conventional RME appliances. It was noted that the intermolar width showed a slight increase with fan-type RME when compared with the conventional RME with no difference in the intercanine width between the two groups. This study also showed greater increase in the nasal cavity width with conventional RME. The upper incisors were tipped palatally in conventional RME group and tipped buccally in fan-type RME group. Both groups demonstrated significant increase in vertical dimension. The fan-type RME avoided expanding and tipping the posterior teeth buccally, thereby not affecting the vertical facial height. However, the changes achieved in dentofacial structures with a conventional RME were more stable than that achieved with the fan-type RME in both the studies. A recent study by Gopalakrishnan et al¹⁹ reported that the ratio between the expansions at intercanine and intermolar regions was nearly 4:1 in the fan-type RME and 0.75:1 in Hyrax. Studies have been done to compare the dentoskeletal outcomes of EDO and the conventional Hyrax expander during the mixed dentition in cleft and noncleft individuals.^{20, 21} The EDO produced greater anterior split of the midpalatal suture and greater increase in the intercanine width than the Hyrax expander. This can be associated with the greater amount of activation of the anterior screw in the EDO group. Similarity between the EDO and the Hyrax expander was observed for intermolar width increases, arch perimeter increases and buccal inclination of the posterior teeth. Increased values of the maxillary dental arch width and arch perimeter changes were seen in cleft patients than in non-cleft patients. This was attributed most probably to the smaller resistance to expansion encountered due to absence of the midpalatal suture and a concomitant greater amount of expansion in the severely constricted maxilla. A recent randomized controlled trial to compare the effects of EDO and fan-type expander (FE) concluded that a greater frequency of posterior crossbite correction was observed in the EDO group. Also, the EDO group showed greater expansion at the intermolar level. The FE however produced greater maxillary intercanine width increase. A greater spontaneous mandibular dental arch width change was observed post-RME with the EDO compared to the FE. Interestingly, the EDO and the FE induced distinct post-expansion arch shapes with the mean final arch shape wider in the molar region for the EDO group and wider in the canine region for the FE group. The ratio between intercanine and intermolar width increases were approximately 1.5:1 with EDO and 3.5:1 with FE. The EDO and the FE are two very feasible options to treat maxillary arch constriction with very similar effects on the canine region. The authors finally concluded that the amount of expansion required in the intermolar region and the presence of posterior crossbites was the deciding factor in the choice of the design of either one of the two expanders.²²

CONCLUSIONS

- Differential rapid maxillary expansion was found to be very beneficial in cleft patients.
- In non-cleft patients with normal intermolar width and anterior maxillary constriction it was advised to expand differentially to avoid deleterious effects like bone dehiscence and gingival recession in the intermolar region.
- To overcome relapse in the intercanine region overexpansion is recommended.
- Novel expanders like EDO are good alternatives for differential expansion.

REFERENCES

1. Kiliç N, Oktay H. Effects of rapid maxillary expansion on nasal breathing and some naso-respiratory and breathing problems in growing children: a literature review. *Int J Pediatr Otorhinolaryngol* 2008; 72 (11): 1595-601.
2. Timms DJ. The dawn of rapid maxillary expansion. *Angle Orthod.* 1999 Jun;69(3):247–250.
3. Bell RA. A review of maxillary expansion in relation to rate of expansion and patient's age. *Am J Orthod.* 1982 Jan;81(1):32–37.
4. Devenish EA, Foster TD, Chinn D. An improved method of differential rapid maxillary expansion in cleft palate. *British journal of orthodontics.* 1982 Jul;9(3):129-31.
5. Weissheimer A, de Menezes LM, Mezomo M, Dias DM, de Lima EM, Rizzato SM. Immediate effects of rapid maxillary expansion with Haas-type and hyrax-type expanders: a randomized clinical trial. *American journal of orthodontics and dentofacial orthopedics.* 2011 Sep 1;140(3):366-76.
6. Nicholson PT, Plint DA. A long-term study of rapid maxillary expansion and bone grafting in cleft lip and palate patients. *The European Journal of Orthodontics.* 1989 May 1;11(2):186-92.
7. Belluzzo RH, Faltin Junior K, Lascala CE, Vianna LB. Maxillary constriction: are there differences between anterior and posterior regions?. *Dental Press Journal of Orthodontics.* 2012 Aug;17(4):1-6.
8. Brunetto M, Andriani Jda S, Ribeiro GL, Locks A, Correa M, Correa LR. Three-dimensional assessment of buccal alveolar bone after rapid and slow maxillary expansion: a clinical trial study. *Am J Orthod Dentofacial Orthop* 2013;143:633-44.

9. Garib DG, Henriques JFC, Janson G, de Freitas MR, Fernandes AY. Periodontal effects of rapid maxillary expansion with tooth-tissueborne and tooth-borne expanders: a computed tomography evaluation. *Am J Orthod Dentofacial Orthop* 2006;129:749-58.
10. Gurel HG, Memili B, Erkan M, Sukurica Y. Long-term effects of rapid maxillary expansion followed by fixed appliances. *Angle Orthod* 2010;80:5-9.
11. Pinheiro FHSL, Garib DG, Janson G, Bombonatti R, de Freitas MR. Longitudinal stability of rapid and slow maxillary expansion. *Dent Press J Orthod* 2014;19:70-7.
12. Broadway, E. S. (1967) An appliance for rapid expansion of the maxilla *Transactions of the European Orthodontic Society*, pp. 163.
13. Foster TD, Chinn D. Differential rapid maxillary expansion in cleft palate. *British journal of orthodontics*. 1977 Jul 1;4(3):139-41.
14. Schellino E. REM: la vite ragno secondo Schellino e Modica. *Boll Interm Orthod. Leone*. 1996;55:36-9.
15. Levrini L, Filippi V. A fan-shaped maxillary expander. *Journal of clinical orthodontics: JCO*. 1999 Nov;33(11):642-3.
16. Garib DG, Garcia LC, Pereira V, Lauris RC, Yen S. A rapid maxillary expander with differential opening. *J Clin Orthod* 2014;48:430-5.
17. Çörekçi B, Göyenci YB. Dentofacial changes from fan-type rapid maxillary expansion vs traditional rapid maxillary expansion in early mixed dentition: a prospective clinical trial. *The Angle orthodontist*. 2013 Sep;83(5):842-50.
18. Doruk C, Bcakci 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. *The Angle Orthodontist*. 2004 Apr 1;74(2):184-94.
19. Gopalakrishnan U, Sridhar P. Assessment of the dental and skeletal effects of fan-type rapid maxillary expansion screw and Hyrax screw on craniofacial structures. *Contemporary clinical dentistry*. 2017 Jan;8(1):64.
20. Garib D, Lauris RD, Calil LR, Alves AC, Janson G, De Almeida AM, Cevidanes LH, Lauris JR. Dentoskeletal outcomes of a rapid maxillary expander with differential opening in patients with bilateral cleft lip and palate: A prospective clinical trial. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2016 Oct 1;150(4):564-74.
21. de Medeiros Alves AC, Janson G, Mcnamara Jr JA, Lauris JR, Garib DG. Maxillary expander with differential opening vs Hyrax expander: A randomized clinical trial. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2020 Jan 1;157(1):7-18.
22. Massaro C, Janson G, Miranda F, Castillo AD, Pugliese F, Lauris JR, Garib D. Dental arch changes comparison between expander with differential opening and fan-type expander: a randomized controlled trial. *European journal of orthodontics*. 2020 Aug 25.