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Original Research Paper

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GROWTH MODULATION TECHNIQUES FOR VERTICAL GROWERS IN SKELETAL CLASS II: A SYSTEMATIC REVIEW

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ABSTRACT

Objective: Class II patients having a retrognathic mandible and hyperdivergent growth tendencies, which makes them most difficult to treat orthodontically. Hence, this systematic review aims at determining the different techniques for growth modulation in patients having a vertical growth pattern in Skeletal class II.

Method: A systematic review of articles selected from PUBMED and other sources was carried out. A total of 23 articles were identified through electronic database searching out of which 9 articles were selected on the basis of PRSIMA format. These studies helped in enlisting different techniques for growth modulation in Skeletal Class II vertical growers.

Results: While there is a lack of strong evidence demonstrating various growth modulation techniques which can be used for skeletal Class II hyperdivergent patients, the high pull headgear, cervical pull headgear, occipital pull headgear, combination pull headgear, other myofunctional appliances used in combination with extra-oral traction force can be used for growth modulation in skeletal class II vertical growers.

KEYWORDS : Growth modulation, Vertical growth pattern, Skeletal Class II; Growth modification, hyperdivergent, high angle, growers, growth pattern, prognathic maxilla, retrognathic mandible, skeletal patterns.

INTRODUCTION

Background

Patterns of facial growth are established early in development.[1] Control of vertical dimension during orthodontic treatment is of major importance in hyperdivergent patients.[3] The degree of facial divergence has an effect upon the total rotation of the mandible, that is more divergent a face, the greater the tendency towards vertical growth .[4] Because Class II malocclusion becomes apparent early in the mixed dentition, the possibility of growth modification and the optimal timing for treatment are both questions of considerable clinical interest.[6] Growth modification attempts to improve the skeletal relationship while keeping dental movement to a minimum.[5] If the hyperdivergent phenotype is left untreated and allowed to progress until the permanent dentition stage of development, the opportunity for growth modification could be lost, and surgical correction may remain as the only option.[1] If growth modification is to be successful in the hyperdivergent phenotype, preventative or early interceptive treatment strategies may be required.[1] Class II patients often have a retrognathic mandible and hyperdivergent growth pattern, which makes them most difficult to treat orthodontically.[2] Class II patients with hyperdivergent tendencies have additional morphological characteristics, the correction of which makes treatment more difficult, including excessive anterior and posterior dentoalveolar heights, open bite, increased lower anterior facial height, steeper mandibular planes, larger gonial angle.[2] Several studies on orthodontically treated patients and as well as on untreated persons, have documented the fact that forces applied to the teeth through orthodontic appliances have a substantial influence on the vertical facial dimension.[4] Factors associated with "favorable growth" in patients with a hyperdivergent phenotype, preventive or early treatment strategies may be required.[1] Factors associated with favorable growth in patients with a hyperdivergent phenotype include an increase in the posterior facial height/anterior facial height ratio, an average or greater amount of "true forward mandibular rotation, enhanced condylar growth.[1] In combination, these factors displace the mandible more anteriorly than inferiorly, which improves the skeletal pattern of hyperdivergent type.[1] Indeed control of the vertical dimension is probably the single most important factor in the correction of hyperdivergent case .[1]

When treating a growing skeletal class II patient with a hyperdivergent facial pattern, orthodontic/ orthopaedic intervention is aimed to achieve three fundamental goals with regards to vertical development of face and dentition: to rotate the maxilla in clockwise direction; to inhibit maxillary and mandibular posterior dental eruption, allowing the mandible to rotate counter clockwise, and to guide mandibular growth in anterior rather than a vertical direction[5]. Hence, this systematic review aims at determining the different techniques for growth modulation in patients having a vertical growth pattern in Skeletal class II.

***Focused question*:** What are the different techniques for growth modulation in patients having a vertical growth pattern in Skeletal class II?

Objective: Determination of different techniques for growth modulation in patients having a vertical growth pattern in Skeletal class II.

MATERIALS AND METHOD

Inclusion criteria:

1. Articles published till 1st January 2018.
2. All articles should be in English.
3. Articles providing information of the participants undergoing growth modulation techniques for Skeletal Class II vertical growth pattern.
4. Full Text articles.

Exclusion criteria:

1. Reviews, case reports, abstracts, letter to editor, editorials and animal studies.
2. Articles describing any facial abnormality related to the patient.

Eligibility criteria

The following selection criterion was applied for the review:

PICO

1. Participants: Participants having skeletal Class II with hyperdivergent growth pattern

2. Intervention: Different growth modulation techniques for participants having skeletal Class II with hyperdivergent growth pattern.

3. Outcome: Effective growth modulation techniques for Skeletal Class II hyperdivergent patients.

Information sources, search strategy and study selection.

Two Internet sources of evidence were used in the search of appropriate papers satisfying the study purpose: the National Library of Medicine (MEDLINE PubMed), Google Scholar, Cochrane Oral Health Groups Trial Register, Cochrane Central Register of Clinical Trials and manual search using DPU college library resources. All cross reference lists of the selected studies were screened for additional papers that could meet the eligibility criteria of the study.

The databases were searched up to and including 2018 using the search strategy.

Keywords

Table I – Keywords used for the data search

PRIMARY KEYWORD	SECONDARY KEYWORD
Growth modulation	Growth modification
Vertical growth pattern	Hyperdivergent, high angle, growers, growth pattern
Skeletal Class II	Skeletal patterns, prognathic maxilla, retrognathic mandible

Search strategy

Search strategy was used for the article search in PUBMED, Google Scholar, and Cochrane Library

Table II- Search strategy

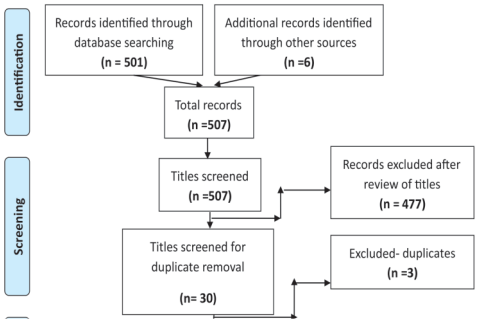
Sr. No.	Search strategy	Number of articles searched	Number of articles selected	Reason for exclusion
SS 1	Growth modulation and vertical growth pattern	5	0	Did not meet the inclusion criteria
SS 2	Growth modulation and skeletal Class II	5	0	Did not meet the inclusion criteria
SS 3	Growth modulation and high angle	21	1	Growth pattern not mentioned
SS 4	Growth modulation and prognathic maxilla	1	0	Did not meet the inclusion criteria
SS 5	Growth modulation and retrognathic mandible	3	0	Growth pattern not mentioned
SS 6	Growth modification and vertical growth pattern	10	0	Growth pattern not mentioned
SS 7	Growth modification and skeletal class II	39	0	Did not meet the inclusion criteria
SS 8	Growth modification and hyperdivergent	2	0	Growth pattern not mentioned.
SS 9	Growth modification and high angle	67	0	Growth pattern not mentioned
SS 10	Growth modification and prognathic maxilla	1	0	Did not meet the inclusion criteria
SS 11	Growth modification and retrognathic mandible	4	0	Did not meet the inclusion criteria
SS 12	Skeletal Class II and hyperdivergent	63	3	Growth pattern not mentioned
SS 13	Skeletal Class II and growth modification	39	0	Did not meet the inclusion criteria
SS 14	Skeletal Class II and retrognathic mandible	49	0	Did not meet the inclusion criteria
SS 15	Growth modification and vertical growth pattern	10	0	Growth pattern not mentioned
SS 16	Vertical growth pattern and retrognathic mandible	12	0	Growth pattern not mentioned
SS 17	Skeletal Class II and high angle	170	4	Did not meet the inclusion criteria

Study selection

Preliminary screening consisted total of 507 articles that were selected. The papers were screened independently by two reviewers. At first the papers were screened by title and abstract. As a second step, full text papers were obtained when they fulfilled the criteria of the study aim. Any disagreement between the two reviewers was resolved after additional discussion. For full-text screening, the following criteria were taken into consideration: i.e. Studies done on skeletal class II growth modulation in vertical growers, a total of 27 articles were included out of which 9 articles were finally synthesized in this systematic review

RESULTS

PRISMA 2009 Flow Diagram



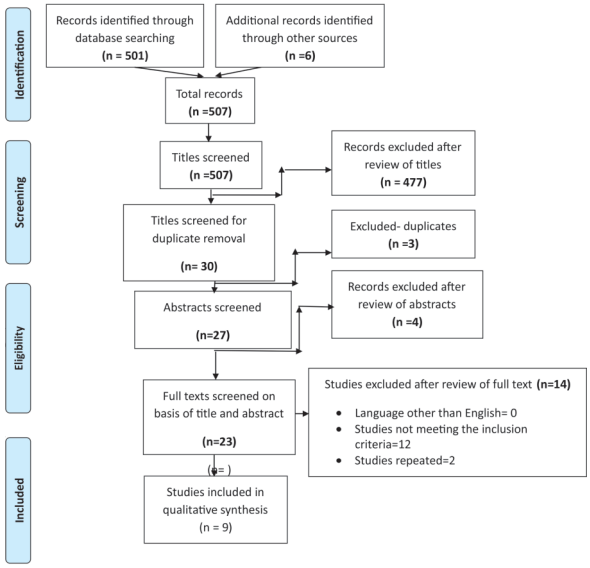


Figure 1: PRISMA flow chart of article identification and selection

Study Characteristics

This study is written in accordance with the PRISMA (Preferred

reporting Items for Systematic Review and Meta-Analyses) (Figure 1) statement for reporting systematic reviews and meta-analysis of studies that evaluate health care interventions

DISCUSSION

Most of the Class II cases are accompanied by skeletal discrepancies. Skeletal Class II could be because of maxillary jaw protrusion, mandibular jaw retrusion or may be due to the combination of both[7]. According to McNamara 75% of class II skeletal discrepancies are the result of mandibular retrognathia [7]. Hence, the treatment modalities for any skeletal problem include Growth modification / dental camouflage / orthognathic surgery[7]. In growing patients all modalities can be applied while in adults only the last two can be applied[7].

The requirements for treatment success by growth modification can be summarized into four major categories: (1) the timing of treatment. (2) case selection. (3) the patient compliance. (4) Appliance selection[7]

Timing of treatment is one of the most important criteria in achieving successful treatment of any skeletal discrepancy. The optimal time for treatment of patients with Class II malocclusions remains controversial. Some clinicians believe strongly that beginning treatment in the mixed dentition before adolescence is advantageous, but others are convinced that early treatment is often a waste of time and resources. We have to keep in mind that more the patient has growth potential the more we gain skeletal growth modification achievement, but if we delay the treatment, we have dental effect rather than skeletal effect.

There are many advantages of the early treatment we have to consider: the ability to modify skeletal growth, better and more stable results, less iatrogenic tooth damage, improved patient self-esteem and parental satisfaction.

Factors associated with "favorable" growth in patients with a hyperdivergent phenotype include an increase in the posterior facial height/anterior facial height ratio, an average or greater amount of "true" forward mandibular rotation, enhanced condylar growth, and a more anterior direction of condylar growth[1]. Indeed, control of the vertical dimension is probably the single most important factor in the correction of the hyperdivergent case[1]. Orthodontists have attempted to limit vertical dimension increase in growing patients by one or more of the following approaches: (1) extra-oral traction with or without a splint, (2) extraction therapy, (3) bite-blocks (passive or active), (4) any combination thereof[1]

When treating a growing patient with a hyperdivergent facial pattern, orthodontic/orthopedic intervention is aimed to achieve three fundamental goals with regard to the vertical development of the face and dentition, to rotate the maxilla in a clockwise direction, to inhibit maxillary and mandibular posterior dental eruption allowing the mandible to rotate counterclockwise and to guide the mandibular growth in anterior rather than vertical direction.

The studies included in this review have enlisted various growth modulations in hyperdivergent skeletal Class II patients.

V. Fotis, B. Melsen, S. Williams, and H. Droschi (1984) suggested use of *extra-oral high pull traction along with a removable maxillary splint* for vertical control in severe skeletal class II hyperdivergent patients[8]. While only slight dorsal repositioning of the maxilla could be observed, an effective retardation of the vertical maxillary development was recorded, as well as a pronounced forward displacement of the mandibular symphysis[8]. Distal movement of the maxillary dentition contributed likewise to the elimination of overjet observed clinically[8]. It was anticipated that the reduction of the vertical growth component in the posterior maxillary region would lead to an anterior rotation of the mandible hence controlling the hyperdivergent skeletal growth pattern[8]. Hence, this study being suggestive of a restriction in the vertical growth component with the use of *extra-oral high pull traction along with a removable maxillary splint.*

Vertical relationships provide the key to planning treatment for an individual patient [12]. When vertical growth is judged to be adequate or excessive as shown by measures of anterior face height, mandibular plane angle or vertical eruption of maxillary molars, the *high-pull molar headgear* is the therapy of choice to inhibit further vertical development As proven by *Peter Brown (1978)* in his study conducted to judge the skeletal and dental changes incurred over one year of treatment with either the face-bow neck strap or the high-pull molar headgear and evaluated 37 Skeletal Class II hyperdivergent patients and concluded the importance of the proper selection of extra-oral appliances , suggestive of the use of high pull headgear for the vertical control in Skeletal Class II hyperdivergent patients [12].

G. S. Antonarakis, S. Kiliaridis (2014) on the contrary, obtained disparate results, concluding that there was no significant sagittal, vertical, or dental post-treatment changes seen with the use of *high-pull* or *low-pull headgear*. Hence, being conclusive that the vertical skeletal pattern of a growing child cannot be altered predictably with the type of headgear used[13] supported the findings of Nikolaos Gkanditis, Demetrios Halazonetis, Evanggelos Alexandropoulos, Nikos Haralabakis (2011)[3] proving that there were no significant pre and post treatment cephalometric vertical skeletal measurements with the use of high or cervical pull headgear.
Michael Burke, Alex Jacobson (1992) evaluated the control of vertical growth pattern in hyperdivergent skeletal class II patients with the use of *cervical and occipital pull headgear* and the changes in vertical control were noted cephalometrically. Burke concluded that after treatment no significant differences were found when mandibular plane angle or facial height changes, anterior or posterior, were compared[9]. Regarding vertical changes, only maxillary molar height, relative to both Sella-nasion and palatal plane, and occlusal plane angle changes were significantly different when cervical and occipital-pull headgear were compared[9].

On the contrary, *cervical headgear* worked synergistically utilizing patient's growth to produce more optimal changes in mandibular position as proven by *Erin Dobbins Zervas, Maria Therese, Galang Boquiren, Ales Obrez, Maria Grace, Costa Viana, Nelson Oppermann, Flavio Sanchez, Enrique Garcia Romero, Budi Kusnoto(2016)* in their study aimed to investigate the effects of cervical and high pull headgear on Skeletal Class II hyperdivergent patients[14]. They concluded that facial profiles in cervical group improved by decreasing facial convexity and angle of mandibular plane to Frankfort horizontal plane and simultaneously increasing the facial axis and its angle, the result of these changes was the protrusion of the chin[14], suggestive of a cervical pull headgear producing a favorable change in the direction of the facial growth from vertical to more horizontal[14].

The headgear can also be used in combination with various other appliances for sagittal as well as vertical growth modulation in skeletal Class II hyperdivergent patients. *Zafer Sari, DDS, Yasar Goyenc, Cenk Doruk, Serdar Usumez, (2003)* aimed to evaluate the comparative efficiency of an *activator-headgear (HG) combination to a Jasper Jumper (JJ) plus occipital HG, which was incorporated into removable upper and lower plates*[15]. The study group consisted of 60 subjects

with mandibular deficiency and a vertical growth pattern 15 of these, 20 were treated with JJ appliance–HG incorporated to removable upper and lower plates, 20 were treated with an activator-HG combination[15].Another 20 subjects who refused orthodontic treatment served as controls[15]. The activator-HG appliance is more effective on the mandible, whereas the JJ appliance is mainly active on the maxilla. Thus, ideal cases for a JJ splinted appliance should be high-angle cases, particularly with maxillary excess and mandibular deficiency[15]. Treatment results in favorable changes in the profile. Although, not methodologically tested, treatment comfort and cooperation were observed to be higher in the JJ group[15]. Hence, proving that the JJ splinted appliance produced favorable changes for the treatment of Skeletal Class II vertical growers.

In another study conducted by *Christopher S. Freeman, James A. McNamara, Tiziano Baccetti, Lorenzo Franchi, Theodore W. Graff (2007)* aimed to evaluate the effectiveness of first phase of *bionator and high pull headgear* treatment followed by a second phase of fixed appliance in growing subjects with skeletal Class II hyperdivergent growth pattern. 24 subjects (13 girls, 11 boys) were treated with bionator with a 4-5mm of posterior bite block that extended anteriorly to the deciduous first molars, along with high pull head gear worn for 10-14 hours a day. concluding that bionator and high pull headgear combination worsened the hyperdivergent facial pattern, hence being suggestive that high pull headgear along with bionator should not recommended for growth modulation of hyperdivergent skeletal Class II patients[5].

A study conducted by *Sabine Ruf, Hanz Pancherz (1996)* evaluated the effectiveness of Herbst appliance in the treatment of Skeletal Class II hyperdivergent patients[16]. They concluded that herbst appliance inherited horizontal condylar growth direction in skeletal Class II hyperdivergent phenotype as the herbst appliance stimulates bone apposition at the posterior pole of the condyle.

The goal of the growth modulation treatment for skeletal Class II hyperdivergent patients is to correct the dental malocclusion, normalize the antero-posterior skeletal relationship and to improve or prevent the worsening of the vertical skeletal relationship. Depending on the mandibular plane angle the vertical skeletal relationships are generally maintained.

To sum up all the gathered evidence, various methods to modulate the growth in skeletal Class II hyperdivergent patients have been listed ranging from extra-oral traction devices for Eg: high-pull headgear /combination pull headgear/ cervical pull headgear/ occipital pull headgear to the extra-oral force traction devices in combination with activator, jasper jumper, bionator, and herbst. Hence, it is the clinician's own acumen to decide which growth modulation appliance works best for the patient for growth modulation in vertical growers in skeletal Class II along with proper case selection to make the appliance work best for the patient with measurable treatment outcomes.

CONCLUSION

While there is a lack of strong evidence demonstrating various growth modulation techniques which can be used for skeletal Class II with vertical growth pattern the following conclusions could be drawn:

1. The high pull headgear was proven the most effective in controlling the vertical growth pattern.
2. The cervical pull headgear, occipital pull headgear, combination pull headgear can be used for the control of hyperdivergent growth pattern in skeletal Class II patients with little effect when compared with high pull headgear.
3. Bionator along with headgear is a poor combination for growth modulation in skeletal class II hyperdivergent patients.
4. Other myofunctional appliances such as activator, herbst, jasper jumper could be used in combination with an extraoral traction force for growth modulation in hyperdivergent patients with activator and high pull headgear combination being the most effective.

LIMITATIONS

This review presented with certain limitations:

1. It was evident that during the course of compiling this systematic review there was limited number of studies fulfilling our selection criteria, upon which results are based.
2. Newer studies need to be carried out with measurable treatment effect for growth modulation in skeletal Class II hyperdivergent patients, with proper case selection, including both skeletal and dental effect.

CONFLICT OF INTEREST

None

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