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***Corresponding Author**
Junqing Ma
E-mail
jma@njmu.edu.cn
Phone
+86-25-85031976

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A Critique Regarding Hypodivergent and Hyperdivergent Skeletal Patterns

Mehjabeen Al Jabri, Dongyue Wang, Tingting Zhou, Lin Wang, Junqing Ma*

Jiangsu Key Laboratory of Oral Diseases, Nanjing Medical University, 210029, Nanjing, China

Abstract

To decide the most accurate treatment plan for orthodontic patients, the principle component is the facial type. According to measurements obtained by the practitioner from radiographs or photographs of the patients whether linear, proportional or angular measurements, those are classified as brachyfacial (short and broad face type), mesofacial (intermediate type) and dolichofacial (long and narrow face type). Both hypodivergent and hyperdivergent facial types are deliberated as unesthetic and therefore enclosed in the orthodontic complication record. To evaluate the vertical skeletal growth pattern of an orthodontic patient, there are many angular and linear analysis methods. Some of the commonly used parameters are facial height ratio [lower anterior facial height (LAFH) to total anterior facial height (TAFH)] and Jarabak's ratio. The angular parameters which are commonly used are the SN-GoGn plane angle (sella-nasion to gonion-gnathion), SN.MP plane angle (sella-nasion to gonion-menton plane), Y-axis, maxillary/mandibular plane (MMA) plane angle and Frankfort to mandibular plane (FMA) plane angle. The maturational status of children is related to the categorical stages of physiological maturity rather than chronological age, which is a non-decisive indicator. Usually, the dental and skeletal factors of class II division 1 are corrected by orthopedic-orthodontic therapeutics in conjugation with bionator. According to few investigations in patients with class III malocclusion, some of the extra-oral appliances which can be used are chin cap, headgear for the mandibular arch, and face mask, etc.

Introduction

The proverb “prevention is better than cure” should govern over the practice of an orthodontist because it helps in minimizing the severity of malocclusion by early treatment of skeletal abnormalities. The field of orthodontics is related to malocclusion, the growth of the face and development of the dentition. To decide the most accurate treatment plan for orthodontic patients, the principle component is the facial type. According to the measurements obtained by the practitioner whether linear, proportional or angular measurements that are obtained from radiographs or photographs of the patients, are classified as brachyfacial (short and broad face type), mesofacial (intermediate type) and dolichofacial (long and narrow face type) [1]. Facial type can also be called as a facial skeletal pattern or facial pattern. According to Siriwat and Jarabak’s classification, these facial types are defined like dolichofacial as hyperdivergent, brachyfacial as hypodivergent & mesofacial as neutral [2]. There was not much change in facial patterns once they were entrenched by Brodie [3]. Therefore, at the commencement of the age of 18 years, the facial tissue growth changes largely appear even though not completed [4]. By adulthood, the facial type variations were further definite according to Bishara and Jackobsen [5]. Karlsen [6] in his studies stated that in between the age of 6-12 years, there were totally contrasting craniofacial growth patterns with the low and high angle. The objectives of this contemporary review were to summarize the differences between hypodivergent and hyperdivergent skeletal pattern and also to assess the various treatment options and utilization of maturational status in the treatment of such cases.

Difference between hypodivergent and hyperdivergent skeletal patterns

Both hypodivergent and hyperdivergent facial types are deliberated as unaesthetic and therefore, enclosed in orthodontic complication record [7]. To evaluate the vertical skeletal growth pattern of an orthodontic patient there are many angular and linear analysis [8]. Some of the commonly used parameters are facial height ratio [lower anterior facial height (LAFH) to (TAFH) total anterior facial height] and Jarabak’s ratio (Fig. 1 and 2) [9]. The angular parameters which are commonly used are SN-GoGn plane angle (sella-nasion to gonion-gnathion), SN-MP plane angle (sella-nasion to gonion-menton plane), Y-axis, maxillary/mandibular plane (MMA) plane angle, Frankfort to mandibular plane (FMA) plane angle [10-12]. During the process of growth, there are higher chances of facial deformities to occur as muscles, bones, and teeth collude confidingly [13]. Gracco et al. [14] reported that the thickness of the mandibular symphysis in total was greater in hypodivergent type than in hyperdivergent type. When compared with abnormal sagittal skeletal patterns, there was more consequence on morphological features of the symphyseal region with the abnormal vertical skeletal patterns [15]. According to some studies, in hyperdivergent cases, there is a supra eruption of upper and lower incisor in order to fill the space which is created by downward and forward movement of mandible resulting in an increase in height of these incisors [16]. In hypodivergent subjects, the cortical bone was 0.08 to 0.64 mm thicker than in hyperdivergent subjects as reported by Horner et al. [17]. According to some studies, there are many regions where the thickness of inter-radicular cortical bone was less than 1 mm like the buccal aspect of both maxilla and mandible in hyperdivergent cases [18, 19]. There are reports of increased upper posterior facial height (UPFH) and smaller size of the sagittal maxillary base in hyperdivergent cases when compared to hypodivergent cases [20, 21]. Many studies showed the various thickness of facial cortical bone in different vertical dimensions [22] and the mini-implant success is indicated by the facial vertical dimension which is an important parameter [23]. Round condyles in hyperdivergent facial types and oval condyles in hypodivergent facial types were recorded [24]. According to some studies, smaller and more superiorly positioned condyles were recorded in hyperdivergent subjects when compared to those with hypodivergent subjects. As a result, it was common to encounter abnormal condylar in

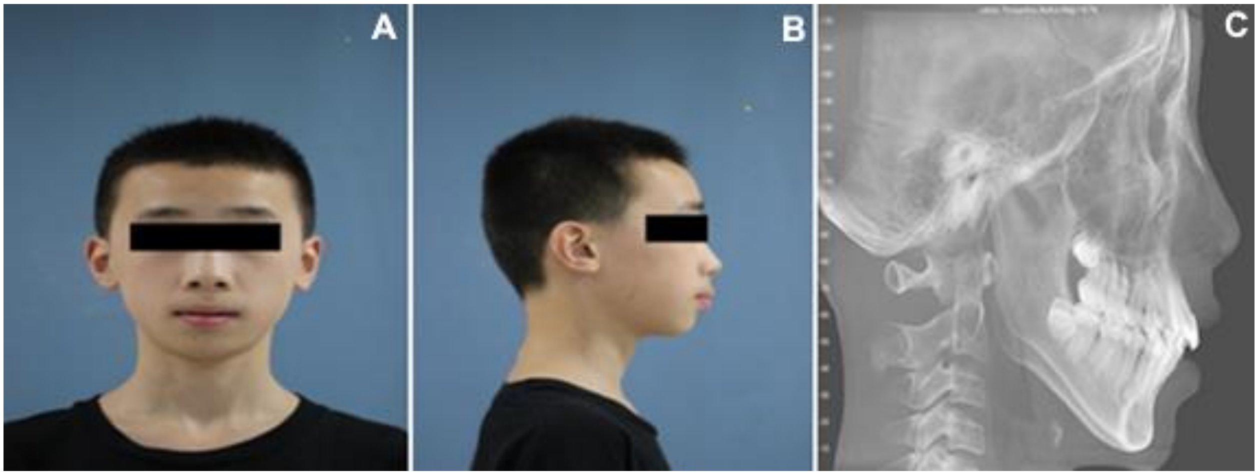

Fig. 1 Pretreatment extra oral photographs and lateral cephalometric radiographs of a patient with hyperdivergent skeletal pattern. (A) Frontal view of the patient with increased lower anterior facial height (LAFH), (B) profile view of the patient with obtuse mandibular plane (MPA) angle, and (C) increased the height of mandibular ramus. Authors authenticate that the consent form of the patient was acquired appropriately. The patient has provided his approval in the consent form for his photographs and clinical and radiographic records to be expressed in the manuscript.

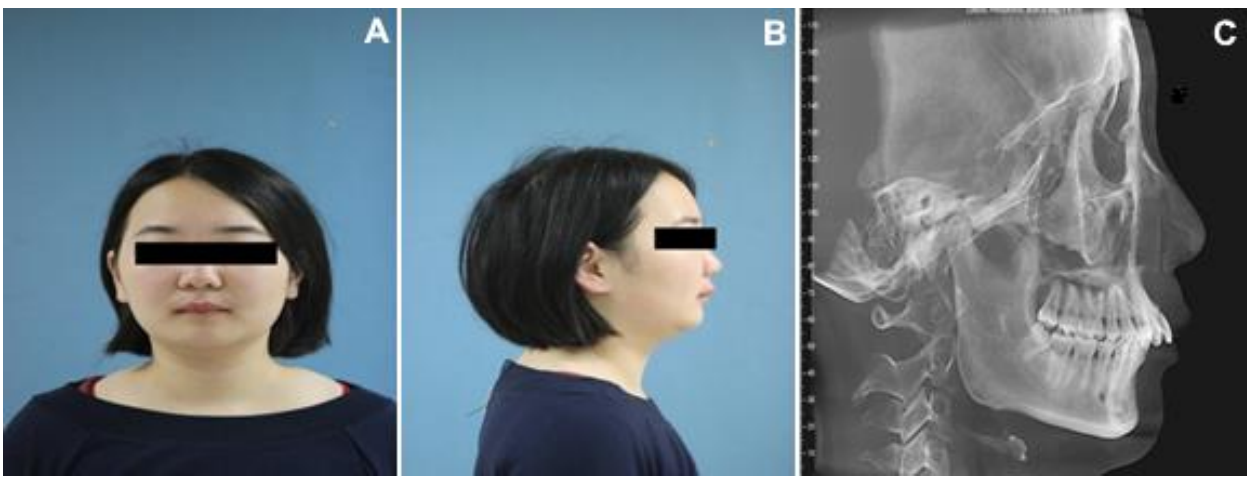

Fig. 2 Pretreatment extra oral photographs and lateral cephalometric radiograph of a patient with hypodivergent skeletal pattern. (A) Frontal view of the patient with decreased lower anterior facial height (LAFH), (B) profile view of the patient with an acute mandibular plane angle (MPA), and (C) decreased the height of mandibular ramus. Authors authenticate that the consent form of the patient was acquired appropriately. The patient has provided her approval in the consent form for her photographs and clinical and radiographic records to be expressed in the manuscript.

morphology hyperdivergent groups [25, 26]. The aim of orthodontic treatments should not only be an alignment of the teeth, but also correcting the position of the condyles. Temporomandibular joint disorders (TMD's) are recurrently detected among patients in need of orthodontic treatment [27- 29]. According to many studies, the mean value for some of the angular parameters like the SN-GoGn plane angle, FMA plane angle, MMA plane angle, SN-MP plane angle, R-angle, Y-axis are <28º and >36º; 21º and >29º; <21ºand >29º; <28º and >36º; <70.5º and >75.5º; and <61ºand >68º for hypodivergent and hyperdivergent cases, respectively. For linear parameters like facial height, ratios are <50% and >55% for hypodivergent and hyperdivergent cases, respectively [30]. In the maxilla and mandible anterioposterior relationship development, mandibular growth plays an important role. The length and height of the mandibular ramus increase in measurements during various stages of growth [31]. The inclination of the mandible in relation to the cranial base is determined by SN-MP (sella nasion-mandibular plane) angle and its mean value is 32º, there was a decrease in SN-MP angle observed from

6 to 16 years of age which was about 36º to 31º and it was age-dependent. According to some studies the overall decrease in males was 7º and in females was 4º [31]. However, the vertical skeletal growth is continuous during the adolescence and post-adolescence stages. The relationship between the craniofacial, dentofacial structures and pharyngeal structures was significant as observed by McNamara [32]. According to his reports, the narrowing of airway's anterioposterior dimension is caused by the hyperdivergent growth pattern along with maxillary excess and retroposition of the maxilla and mandible. According to the observations of Battagel et al. [33] in subjects with class II and constricted width of the pharyngeal upper tract, there was increased posterior position of the hyoid bone. In subjects with class III, the hyoid bone lies in a more forward position as shown by Adamidis and Syropoulos [34]. The hyoid bone is located nearer to the mandibular plane and posteriorly that is towards the cervical vertebrae in subjects with brachyfacial type as reported by some studies [35]. In contrast to brachyfacial type, the hyoid bone position in normal and dolichofacial types is more inferior and anterior [36]. According to some studies, the position of the tongue in class II malocclusion cases is usually higher than the position of the tongue in cases of hyperdivergent skeletal pattern. In patients with the vertical skeletal pattern, the airway anterioposterior dimensions get narrower and for breathing through the mouth, the maintenance of oral airway is important and to achieve this, tongue and mandible is deranged downwards and backward and head should be inclined backward as reported by Abu Allhaja and Al-Khateeb [37].

Cervical vertebrae maturation and sexual dichotomy in hypodivergent and hyperdivergent skeletal patterns

By the evidence from the past investigations done by utilizing the cervical vertebrae maturation indicator (CVMI) or various radiographic systems, the female subjects had early acquirements of about 15 months from 2 to 5 stages of cervical vertebrae maturation (CVM) than male subjects [38, 39]. According to a few studies of SN/MP plane angle, there has been the anticipation of deferred acquisition in relation to pubertal stage 3 CVM in hypodivergent and hyperdivergent subjects [40]. Among different facial types, there was noticeable sexual dimorphism with facial dimension [41]. In female subjects, the sexual dichotomy was observed in the depth and height of symphysis which was small when compared to male patients [42]. There was a significant sexual dichotomy observed associated with ramus height and it was increased in the hypodivergent group in comparison with hyperdivergent group [43]. In the adolescence phase, taking advantage of growth changes in patients is one of the purposes of orthodontic treatment [44]. The final results of orthodontic treatments, treatment planning, and diagnosis are considerably influenced by the maturational status of the patient and are more related when the treatment planning is established certainly on orofacial growth by utilizing functional appliance, extra oral traction, orthognathic surgery and orthodontic retention [44]. The best of child's maturational status is related to categorical stages of physiological maturity than chronological age, being not a decisive indicator. The estimation of physiologic age can be done by skeletal, somatic, dental and sexual maturity [45, 46]. Cervical vertebrae maturity indicator (CVMI) stages are categorized as CVMI 1 (initiation stage), CVMI 2 (acceleration), CVMI 3 (transition), CVMI 4 (deceleration), CVMI 5 (maturation) and CVMI 6 (completion) [47, 48]. All the patients are subjected to lateral cephalograms for the assessment of cervical vertebrae maturation indicator stages. For the assessment of skeletal maturity, there are five stages of middle phalanx of the third finger (MP3) growth, which are primarily based on epiphyseal growth changes as proposed by Hagg and Taranger [47] and [48]. The MP3 stages were classified as MP3-F, MP3-FG, MP3-G, MP3-H and MP3-I, which can be recorded by subjecting all the patients to radiograph of left hand including only the fingers and the wrist in the radiographic image.

Treatment options for hypodivergent and hyperdivergent cases

If there are various factors that arbitrate to malocclusion, the orthodontist should prefer and consider fixed and functional appliances in conjugation during the certain growth period, because it can produce better results compared to the results achieved by using fixed and functional appliances [49, 50]. Usually, the dental and skeletal factors of class II division 1 are corrected by orthopedic-orthodontic therapeutics in conjugation with bionator [51]. The banter has both dentoalveolar and skeletal effects and has been used in many studies since introduction in 1964 [51]. With bionator/activator appliances during the treatment, mandibular length and protrusion were significantly increased as reported by other studies [52]. In long-term post-treatment phase, the maxillomandibular relationship was stable with the treatment of bionator [53]. According to some studies, there was a counterclockwise rotation of mandibular plane angle during long-term post-treatment phase [54]. A significant increase was reported in posterior height and lower anterior face height both in treatment and post-treatment phase [55]. There are some functional appliances like mandibular growth advancer (MGA) and power scope class II corrector that can also be used [56]. In patients with class III malocclusion, some of the extraoral appliances which can be used are chin cap, headgear for the mandibular arch, face mask, etc. With the use of chin cap, mandibular growth is retarded and mandibular remodeling occurs as it rotates the mandible backward and also increases the anterior facial height in a patient with short lower facial height and prognathic mandible [57]. The use of face mask was effective in class III cases, which exhibits brachyfacial types and maxillary retrusion [58]. There was a significant increase in mandibular plane angle with protraction face mask therapy [59].

Conclusions

Early diagnosis helps in intercepting and preventing the severity of malocclusion. Assessing the maturational status of the patients before designing orthodontic treatment plan plays a key role to achieve a successful result of treatment. CVMI stages and MP3 stages are more reliable sources for predicting the physiologic age, as the chronological age is not a reliable indicator for carrying out the treatment in growing patients. Most of the hypodivergent cases exhibit Angle's class II division 1 malocclusion and most of the hyperdivergent cases exhibit Angle's class III malocclusion. For treating most of the class II division 1 cases, bionator appliance is being used as it has both dentoalveolar and skeletal effects and to treat most of the class III cases chin cap, headgear and face mask is being used. Hence, an orthodontist should perform a thorough assessment of pre-adolescent, adolescent and post-adolescent phases of patients when dealing with hyperdivergent and hypodivergent skeletal patterns in growing individuals.

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Conflict of interest

The authors declare that they have no conflict of interest

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