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Biological age vs. skeletal age – A Case Report

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Abstract

Terms like biological age, skeletal age and dental age often dodge the clinician while planning the treatment. Reason being large amount of variation probably because of evolution. A clear understanding of all of them is very important to diagnose a treatment for maximum efficiency. Also regional variation between them can't be ruled out. Taking into consideration all the above factors a case report is presented depicting non-correlation between biological age and skeletal age. This case is of 18 years old female patient with 8˚ ANB. Although, the patient was post pubertal but her CVMI stage was IV, indicative of growth expectation. This patient was put on fixed functional appliance and adequate result was achieved.

Keywords: Biological age, Chronological age, Dental age, skeletal age, skeletal maturation and cervical vertebrae maturation indicators (CVMI)

Introduction

Biological maturation is a comprehensive concept, which is often conceived as a series of successive transformations through the time, leading to the attainment of the adult state. Maturity indicates a general concept at any specified age or level during the process of development. The degree of maturity has been determined by various indicators like biological or chronological age,

bone development, height, weight, dental development and sexual maturation characteristics.[1-3]The correlation coefficient between developmental status and chronological age is about 0.64 and the correlation of dental age with chronological age is about 0.49.[4] Differences in the development among children of the same chronological age have led to the concept of physiologic age, which is a reflection of the degree of skeletal and dental maturation.[5]

However, the optimal timing for orthodontic treatment is linked intimately to the identification of periods of craniofacial growth that can contribute significantly to the treatment of patients with skeletal discrepancies. The use of radiographic analysis to estimate skeletal maturation stage is a widely used method for predicting the timing of pubertal growth and for estimating growth velocity and the proportion of growth remaining.[6]

The cervical vertebrae maturation (CVM) method was introduced by Lamparski for use in growth assessment, allowing skeletal age evaluation and eliminating the need for additional radiographic exposure since the vertebrae are already recorded in the lateral cephalogram taken as a pre-treatment record.[7]

Several dento -facial orthopedic treatments on growing patients have been shown to have their maximal effect if performed during specific skeletal maturational phases, such as the pubertal growth spurt. This is particularly true for skeletal Class II malocclusion patients, in whom functional appliances may have increased skeletal effects if treatment is performed during peak mandibular growth. In this regard, chronological or biological age has been shown not to be a valid predictor of skeletal maturation phases. Indeed, the clinical applicability of chronological age as an indicator of the onset of the pubertal growth spurt in the individual patient is limited, as the growth spurt is influenced by several other factors, including genetics, ethnicity, nutrition, and socioeconomic status.[8]

In this case report an adolescent skeletal Class II patient with chronological and skeletal age variation was treated via all first premolar extraction for correction of crowding along with fixed functional appliance to mask skeletal deficiency by utilizing residual growth.

Case Report

A 18 Year old female patient reported to our department with a chief complaint of irregularly arranged teeth in her upper and lower front region. The patient also felt that her upper front teeth were not overlapping her lower front teeth. She presented with no relevant medical and habit history.

Diagnosis

Extraoral examination (Fig 1.) of the case revealed mesocephalic, mesoprosopic, convex facial form with no gross asymmetry. Patient presented with incompetent lips and a typical Class II malocclusion div 1 features.

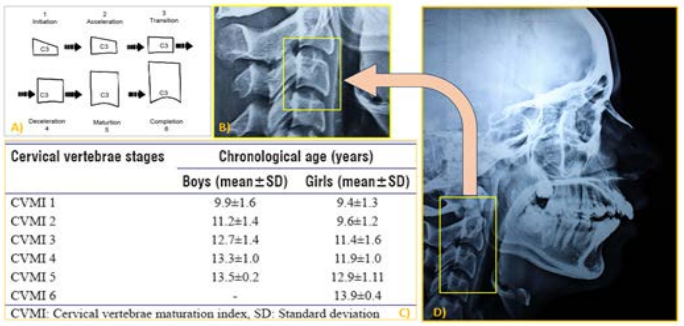
Temporomandibular joint (TMJ) assessment showed no history of pain or clicking on maximum opening or closing of the jaw. The right and left excursive movements were normal with maximum mouth opening being 39 mm.

Intraoral examination (Fig 1.) revealed a V shaped constricted upper arch with matching skeletal midline and U shaped lower arch. Lower dental midline was shifted 3mm towards left side. She had end on molar relationship bilaterally with 2 mm anterior open-bite. Mesio-angular rotation was noted in relation to 13 and disto-angular rotation was noted in relation to 34, while scissor bite was noted in relation to 17. Moreover, crossbite was seen in relation to 36 and 43, whereas 34 was out of occlusion.

Fig 1: Pre-Treatment records

Panaromic radiographic examination (fig 1.) revealed adequate bone support for orthodontic mechanotherapy. Third molar teeth were visible in all four quadrants while 48 was horizontally impacted. TMJ space appeared with normal size, shape and position of the condylar heads.

Lateral cephalometric assessment (fig 1. and Table 1) suggested a Class II skeletal base with hypodivergent jaw bases as the ANB is 8° and MPA is 30°. As clinical examination already revealed proclined upper and lower incisors hence the 1/NA, 1/NB and IMPA angulations were found to be increased i.e. 26°, 30° and 103° respectively. It also revealed Cervical vertebrae maturation indicators (CVMI) stage IV growth status (Fig 2.) which indicate variation between biological age and skeletal age.



Cervical vertebrae stages	Chronological age (years)	
	Boys (mean±SD)	Girls (mean±SD)
CVMI 1	9.9±1.6	9.4±1.3
CVMI 2	11.2±1.4	9.6±1.2
CVMI 3	12.7±1.4	11.4±1.6
CVMI 4	13.3±1.0	11.9±1.0
CVMI 5	13.5±0.2	12.9±1.11
CVMI 6	-	13.9±0.4

CVMI: Cervical vertebrae maturation index, SD: Standard deviation

Fig 2: (A) - Stages of Cervical vertebrae maturation index(CVMI), (B) Pre-treatment cephalogram section of Cervical vertebrae, (C) Correlation Between CVMI and chronological age (D) Pre-treatment cephalogram.

Table 1: Cephalometric Readings of The Patient's Lateral Cephalograms Tracing.

	Norm	Pre-Treatment	Post Treatment
SNA	82°	85°	84°
SNB	80°	77°	78°
ANB	2°	8°	5°
MPA	32°	30°	28°
1/NA	22°	26°	20°
1-NA	4.0mm	3.1 Mm	2 Mm
1/NB	25°	30°	28°
1-NB	4.0mm	4.5 Mm	5.2 Mm
IMPA	90°	103°	93°
1/1	131°	115°	145°
Wits	0mm	4.2 Mm	5.1 Mm

Model analysis

Arch perimeter analysis suggested 3mm of maxillary tooth material excess and Carey's analysis showed 5 mm mandibular tooth material excess. Bolton's analysis indicated a mandibular anterior tooth material excess of 3 mm while overall mandibular tooth material excess was 2.3 mm.

Treatment objectives

Treatment goals were to correct the patient's class II skeletal and dental relationships to correct the constricted maxillary arch along with correction of rotations,

proclination and open-bite among the teeth and achieve an esthetically pleasing soft-tissue profile.

Treatment plan

Four treatment modalities were proposed.

The first treatment modality required extraction of upper first premolars and finish the case in class II molar relationship. Second option, required extraction of upper first premolars and lower second premolars bilaterally allowing us to finish the case in an ideal Class I molar and canine relationship.

Third modality follows extraction of maxillary second premolars and mandibular first premolars along with BSSO advancement after decompensation.

Fourth and last, involves all first premolars extraction, decompensate followed by the use of fixed functional appliance to address the skeletal problem and best utilize the remaining growth potential of the patient for a much more aesthetic profile.

The first two treatment options were discarded as it doesn't improve facial profile so much. Third treatment option was discarded as the patient sought orthodontic treatment only in form of a conservative approach and was not willing for surgery and opted fourth treatment option which improve dental as well as soft tissue profile (Fig 3.).

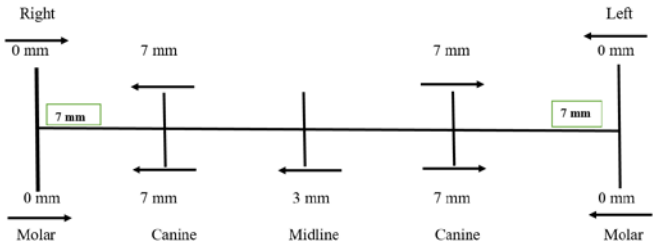


Figure 3: Dental VTO (Anticipated Treatment Change in Maxillary and Mandibular Arch)

Treatment progress

Before starting of orthodontic treatment, horizontally impacted 48 was extracted and 18 was extracted as a balancing extraction. Full fixed preadjusted Edgewise appliance MBT 0.022" (3M Unitek™ Gemini Metal Brackets) prescription was placed to level and align both arches starting from 0.012" NiTi arch-wire. Banding and bonding of upper first and second molar were done along with the placement of TPA on first molar for anchorage. Patient was referred for extraction of upper and lower first premolars before commencing levelling and aligning. Posterior bite plate was given in upper arch till distal to first molar along with cross elastic in relation to 17 and 47 to correct scissor bite. After 3 months of treatment scissor bite was corrected and gradually reached 0.016" Ni-Ti arch-wire. After achieving leveling and alignment of both the arches in eight months, 0.019" × 0.025" stainless steel archwire was inserted subsequent to consolidation of anterior teeth. Active tie back were given in upper and lower arch for space closure and after 5 months of retraction phase all extraction space were closed and also placed a 1.5 mm x 8mm (SK surgical) midline mini-implant, that is, between the upper central incisors at the mucogingival junction to maintain the anterior torque (Fig 4.).

Fig 4: Upper Arch: 0.019" x 0.025" SS and 1.5mm x 8mm Midline Mini-implant, Lower Arch: 0.019" x 0.025" SS

After completion of space closure 0.019" × 0.025" stainless steel arch-wire was inserted subsequent to consolidation of figure eight by ligature wire. A fixed functional Class II corrector appliance "the Powerscope ™" (American Orthodontics), was placed between first & second molar in upper arch (contrary to the usual placement between second premolar and first molar) and distal to canine in lower arch with equal 3 mm activation on both side to correct the mandibular retrognathism and

achieve Class I molar and canine relation (Fig 5.). To compensate for the lower incisor flaring, a 10° of lingual crown torque with respect to 41,42,31,32 was incorporated in lower arch wire. A unilateral activation 2mm of Powerscope was done on left side after 4 months of initial activation to correct dental midline.

Fig 5:Upper & Lower Arch: 0.019" x 0.025" SS with Powerscope

After nine months, the Powerscope appliance was removed and a lighter gauge wire i.e. a 0.016" stainless steel archwires were inserted in both the arches.

After 28 months of active treatment, dental Class I relationships was achieved (Fig 6.). The patient's facial profile changed from convex to straight due to favorable growth of mandible. Settling of dentition was done on 0.014" Ni-Ti. The patient presented with good intercuspation except interdental gingival enlargement between 13 -14 and 23-24. Molar relationship on left side was super Class I which was overcorrected anticipating mild amount of relapse subsequent to removal of fixed functional appliance.

Fixed retainer were given in relation to upper and lower arch along with begg's wrap around retainer.

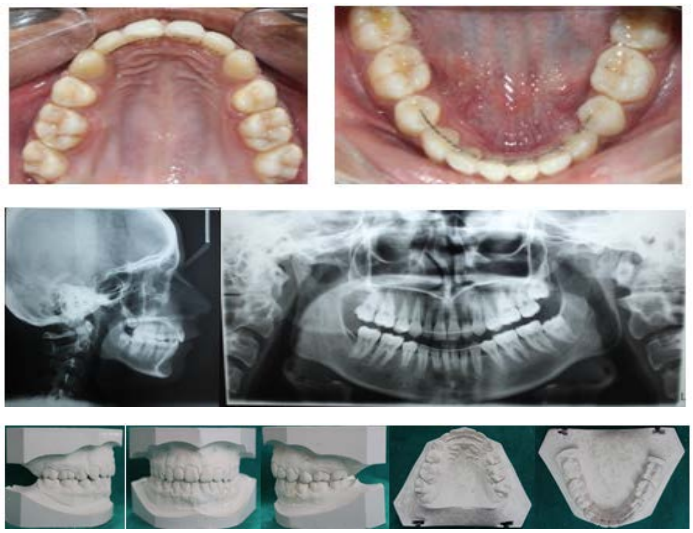


Fig 6: Post-treatment records

Results

The fixed functional phase delivered a remarkable correction of skeletal and dental discrepancy (Fig 6.). The patient presented with a very much pleasing profile. The post treatment assessment results achieved by the Powerscope are shown in Table 1. The changes seen are as follows: ANB angle was reduced from 8° to 5°, a 10° decrease is observed in IMPA, 6° reduction in 1/NA and 30° increase in inter incisor angulation. (Fig 6, Table 1) Dental midline was also coinciding to each other.

Cephalometric superimpositions illustrates and indicates significant condylar growth owing to the fixed functional appliance (Powerscope) (Fig 7.)

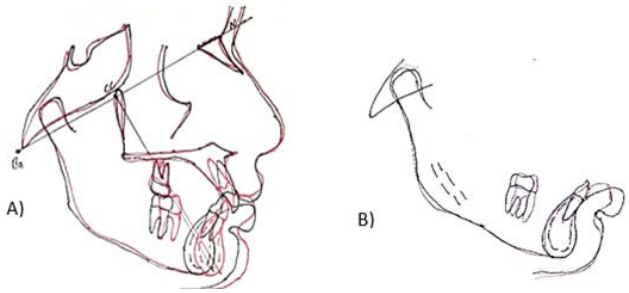


Fig 7: Superimposition: (A) Basion-Nasion at CC (centre of cranium), (B) At mandibular internal structure

PAR Scoring Assessment

Peer assessment rating (PAR) index was assessed under heading of anterior segments (upper and lower), buccal

occlusion, overjet, overbite and centre line for pre-treatment and post-treatment intraoral records. Assessment of pre-treatment of intraoral records shows that she had 18 PAR scoring points which reduced up to 3 PAR scoring points in post-treatment intraoral records. So change in PAR score was 15 points and percentage change in PAR score was 83% which shows "improved" orthodontic treatment results (Table 2).

CASE NUMBER		Pre-Treatment				Date						UN-WEIGHTED TOTAL	WEIGHTED TOTAL
PAR COMPONENTS	RIGHT										LEFT		
Upper anterior segments	3-2	2	2-1	2	1-1	1	1-2	2	2-3	0		7	X1
Lower anterior segments	3-2	0	2-1	0	1-1	1	1-2	1	2-3	1		3	X1
Buccal occlusion	Antero-posterior				Right	2			Left	2		4	X1
	Transverse				Right	0			Left	0		0	X1
	Vertical				Right	1			Left	1		2	X1
Overjet	Positive		0		Negative							0	X6
Overbite	Overbite		1		Openbite							1	X2
Centre line	1											1	X4
										TOTAL		18	

CASE NUMBER		Post-Treatment				Date						UN-WEIGHTED TOTAL	WEIGHTED TOTAL
PAR COMPONENTS	RIGHT										LEFT		
Upper anterior segments	3-2	0	2-1	0	1-1	0	1-2	0	2-3	0		0	X1
Lower anterior segments	3-2	0	2-1	0	1-1	0	1-2	0	2-3	0		0	X1
Buccal occlusion	Antero-posterior				Right	0			Left	0		0	X1
	Transverse				Right	0			Left	0		0	X1
	Vertical				Right	1			Left	1		2	X1
Overjet	Positive		0		Negative							0	X6
Overbite	Overbite		0		Openbite							0	X2
Centre line	1											1	X4
										TOTAL		3	

PAR SCORE		IMPROVEMENT	
Change in PAR score	15	Greatly improved	
% change in PAR score	83	Improved	✓
		Worse or no different	

Table 2: PAR scoring assessment of outcome

Discussion

According to Baccetti, the peak in mandibular growth occurs during the year after cervical stage 3 when concavities at lower border of second and third cervical vertebrae are present. Although the chronological age is the least accurate indicator describing developmental maturation, it is the mostly used indicator of patient maturation by parents and or even clinicians.[9, 10]

Cericato et al., suggested that skeletal assessment using cervical vertebrae is reliable and that better reproducibility values can be found in females, when compared to Baccetti's, by using the Hassel and Farman method.[11]

Maturation stages 3 and 4, related to the maximum peak of growth and greater craniofacial growth, occurs between the chronological ages of 11 and 14 years (11.2±2.6 years for stage 3 of maturation, and 13.8±1.7 for stage 4 of maturation). The maturation stage 5, related to the end of growth and in which the final 5% to 10% vertical growth of the individual is still to be completed, was reached at a mean chronological age of 15.1±1.2 years.[12]

Wong et al., stated that the CVM method is not sensitive for detecting maturity except in the growth spurt period and that studies with wide age range, such as 5 to 18 years.[13]

The Power scope is used for the correction of class II malocclusion by utilizing the remaining growth. Power scope facilitates the forward and downward displacement of the mandible along with distal tipping of the maxillary dentition, henceforth, contributing to the correction of a Class II malocclusion. A common dent alveolar side effect seen is the proclination of lower anterior which was prevented by adopting the following measures (1) cinching back of mandibular archwire 2) figure of eight consolidation of lower arch and 3) incorporation of lingual crown torque in anterior segment of lower arch wire.[14]

The orthodontic treatment goal includes obtaining a good facial balance and an optimal static and functional occlusion and stability of the treatment results. This present case is one of the good example for explaining the dental camouflage over orthognathic surgery, as patient compliance and patient's perception of their facial esthetic becomes integral part of decision making over cephalometric values for example ANB greater than 8^0 (generally considered for orthognathic surgery).The more dissatisfied the patients are with their facial appearance, the more likely they will choose a surgical instead of an

orthodontic approach. No much difference in the outcome of treatment was found when comparing the orthognathic surgery and dental camouflage, in terms of esthetic perception of the subject.[15]

Conclusion

The study of craniofacial growth using indicators such as dental age and skeletal maturation is relevant because of its clinical implication in treating children and adolescents at their optimal growth peaks, in order to achieve greater effectiveness. In patients with incomplete skeletal growth, skeletal age corresponds to a higher level of maturation than predicted by the patient's chronological age in both female and male patients.

Till now, indicators that accurately determine craniofacial growth have not yet been developed. It is recognized as an individual process involving multiple factors that hinder its measurement.

All those Class II conditions which occur due to retruded mandible can be corrected with/without extraction with the help of fixed functional Class II corrector appliance. This appliance system provided best treatment options for the Class II correction by utilizing remaining growth potential of patient, especially for non-compliant patients, by sagittal forward displacement of the mandible.

Declaration of patient consent

The author certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity can't be guaranteed.

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