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Original Research Article

Duration of the pubertal peak in skeletal class I, class II -div 1, div 2 and class III subjects -A cephalometric study

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Abstract: The purpose of this study is to predict the accurate timings for pubertal growth peaks for Class I, Class II - Div 1, Div 2 and Class III. Comparisons are made between the period of the pubertal growth peak in Class I, Class II –Div 1, Div 2 and Class III subjects. This would help the orthodontist in the following ways: 1) For predicting correct treatment time for all malocclusions. 2) For benefiting the patient by guiding the growth modification treatment during the favorable time in a balanced and harmonious manner. 3) To assess skeletal age and pubertal growth spurts are of prime importance in orthodontics and dentofacial orthopedics, for diagnosis, treatment planning, and retention. This study has used the Cervical Vertebral Maturation (CVM) technique for the finding of the peak in growth of mandible, based on the scrutinizing and analysising of the second through fourth cervical vertebrae in a single cephalogram. The lateral cephalograms of orthodontically untreated or new subjects/ patients, ages 8 through 18 years, were studied. The CVM stage on each radiograph was assessed and evaluated according to the Baccetti et al method. Skeletal relationship was evaluated by Steiner's analysis (By Steiner's analysis: ANB (A point, Nasion, B point) shows whether the relationship amongst the maxilla and mandible is normal (skeletal class I relationship (+ 2 degrees), a skeletal Class II (+4 degrees or more), or skeletal Class III (0 or negative). The Duration of pubertal peak in Class I was 5 months longer than class II patients and 6 months shorter than class III patients. The pubertal peak for Class I subjects lasted 1 year 4 months (in agreement with previous indications of the literature) whereas in subjects with Class II div 1& div 2 malocclusion it lasted for a shorter period (11 months) and Class III malocclusion it persisted for a longer period (1 year 10 months).
Keywords: Pubertal growth, Cervical Vertebral Maturation, Pubertal peak

INTRODUCTION

The timing of the treatment/ management onset has become as critical as the selection of the specific treatment protocol in orthodontics and dentofacial orthopedics [1]. The assessment of Individual skeletal maturity can be done by means of several useful biological indicators like skeletal maturation of the hand, wrist and increase in body height [2, 4]; dental development and eruption [5, 6]; menarche or voice changes [7]; and cervical vertebral maturation [8].

CVM method can be significantly used as a MI (maturational index) for detecting the optimal onset treatment period for deficiencies of mandible by means of functional jaw orthopedics [9]. The most beneficial response of functional treatment of Class-II skeletal disharmony depends on the biological response of the condylar cartilage, which is related to the growth rate of the mandible. Early treatment of Class III malocclusion is beneficial [10]. The CVM method had been applied for an ideal treatment timing for the correction of vertical excess of the face by means of a bonded rapid maxillary expander in association with a vertical- pull chincup [1]. The new version of the CVM method has advantage that mandibular skeletal maturity can be appraised on a single cephalogram and through the analysis of only the second, third and fourth cervical vertebrae only [11].

Class II treatment before or during the pubertal growth spurt did induce significant favourable skeletal changes (by restricting the maxillary forward growth in prepubertal patients and enhancing mandibular growth in pubertal patients).The dentoskeletal correction of Class II malocclusion with 1-phase non-extraction treatment occurred in patients who were treated during the pubertal growth spurt [13]. The onset, the duration, and the completion of the pubertal spurt in mandibular growth had been relevant aspects in dentofacial orthopedics, as it influences treatment outcome and

stability by the maturational status of the patient. The literature do provide information about the duration of the pubertal peak for Class I occlusions, but no information about the duration of the growth peak in persons with Class III malocclusion. Reyes et al had reported earlier that the pubertal growth spurt starts late and leads to an increased amount of mandibular lengthening in Class III patients vs. persons with normal occlusion [14].

METHODS

The present study was done to estimate and compare the duration of the pubertal growth peak in Class I and Class II div 1& div 2 and Class III subjects. Ethical committee clearance for undergoing the study was obtained from Institutional ethical clearance committee

Subject selection criteria

The lateral cephalograms of 209 orthodontically untreated patients, ages 8 through 18 years, were investigated and evaluated. Subjects were randomly selected from patients who presented to the Department of Orthodontics and Dentofacial Orthopedics, Sri Sai College of Dental Surgery, Vikarabad. The CVM stage on each radiograph was assessed according to the six stages of cervical vertebral maturation described by Hassel and Farman, a modification of Lamparski's criteria, which assessed maturational changes of the second, third and fourth cervical vertebrae [20], and skeletal class was assessed according to Steiner's cephalometric analysis [12]. The CVM staging was performed by one investigator on a conventional viewing screen.

Inclusion criteria

- Good quality of cephalograms.
- No earlier orthodontic treatment.
- No extracted teeth or congenitally missing.
- No systematic or acquired diseases that could have affected over-all development.
- Skeletal relationship assessed by Steiner's analysis.
- This study used the Cervical Vertebral Maturation (CVM) technique for the detection of the peak in mandibular growth, based on the analysis of the second through fourth cervical vertebrae from a single cephalogram [11].
- Skeletal stages CS3 / CS4 based on the CVM method. CS3 represents the initial stage of the acceleration of the pubertal growth peak, and CS4 presents the final stage of the acceleration of the pubertal growth peak in adolescents [14].

Exclusion criteria

- Subjects with muscular dystrophy, congenital abnormalities affecting growth and development, traumatic lesions of cervical vertebrae.

Materials:

The radiographs taken with informed consent included Lateral cephalogram radiograph.

Methodology:

The following points were recorded from the subjects:

- Age and date of birth: the age considered was his or her chronological age in completed years, without taking the months into consideration.
- Sex: the total samples were not differentiated into males and females, they were randomly selected.

ARMAMENTARIUM

Radiographs

1. Lateral cephalograms

Patient positioning procedure:

- The radiographs were taken at standardized magnification, with the head in its natural head posture.
- Teeth in centric occlusion.
- Lips at relaxed position.

The radiographs were exposed and developed using the standard developer and fixer in a dark room by the same operator to eliminate errors and magnification which is of minimal concern.

As described by Hassel and Farman [20] the six stages of cervical vertebral maturation and a modification of Lamparski's criteria, by assessing the maturational changes of the second, third and fourth cervical vertebrae.

Statistical analysis

All the analysis were done using SPSS version 14. A p-value of <0.05 was considered statistically substantial. Comparison of mean age between different stages was done using independent sample t test.

Table 1: Descriptive analysis for all the Class I, Class II div1 & div 2 and Class III groups are shown

CLASS I	12y 0mo	13y 4mo	1y 4 mo
CLASS II div 1	12y 5mo	13y 4mo	11 mo
CLASS II div 2	12y 2mo	13y 1mo	11 mo
CLASS III	11y 8mo	13y 6mo	1y 10mo

Table-2: Average Duration of the Pubertal Peak Interval in the Two different Types of Skeletal Disharmony

No. Of records	Type of malocclusion	Cervical stage	Minimum	Maximum	Standard deviation	Mean age
23	Class I	CS3	11 y	13 y	.90	12 y 0 mo
12	Class I	CS4	13 y	14 y	.51	13 y 4 mo
24	Class II div 1	CS3	11 y	13 y	.51	12 y 5 mo
14	Class II div 1	CS4	12 y	14 y	.85	13 y 4 mo
19	Class II div 2	CS3	11 y	14 y	.79	12 y 2 mo
7	Class II div 2	CS4	13 y	14 y	.38	13 y 1 mo
13	Class III	CS3	10 y	14 y	1.63	11 y 8 mo
21	Class III	CS4	11 y	15 y	1.25	13 y 6 mo

Malocclusion	CS3	CS4	CS3-CS4
Cervical stage			

Table 3:

Group	Stage						Duration difference	p-value
	3			4				
	Mean	SD	N	MMean	SD	N		
1	12.00	.90	23	13.42	0.51	12	1.42	<0.001; Sig
2	12.48	0.51	23	13.43	.85	14	.95	<0.001; Sig
3	12.21	0.79	19	13.14	0.38	7	.93	<0.001; Sig
4	11.85	1.63	13	13.57	1.25	21	1.72	0.001; Sig

N is the sample size in each group respective to the stage. p-value signifies that the mean age in each group was significantly higher.

RESULTS

The present investigation sought to obtain information about the duration of the pubertal peak in untreated persons with Class II division 1& 2 and Class III skeletal relationships when compared to those with skeletal Class I relationships. Comparison of mean age between different stages was done using independent sample t test. The average chronological age at onset of the pubertal peak for skeletal Class I was12 years and ended at 13 years 4 months which was statistically significant (p<0.001). (Table 3 &Graph 1).

The average chronological age at onset of the pubertal peak for skeletal Class II div1 was 12 years 5 months and ended at 13 years 4 months which was statistically significant (p<0.001). (Table 3 & Graph 1).

The average chronological age at onset of the pubertal peak for skeletal Class II div 2 was 12 years 2 months and ended at 13 years and 1 month which was statistically significant (p<0.001). (Table 3 & Graph 1).

The average chronological age at onset of the pubertal peak for skeletal Class III subjects was 11 years 8 months and ended at 13 years and 6 months which was statistically significant (p 0.001). (Table 3 & Graph 1)

The pubertal peak for skeletal Class I subjects lasted 1 year 4 months.(Table 2)The pubertal peak for Class II div 1& div 2 malocclusion lasted for a shorter period of 11 months. (Table 2)

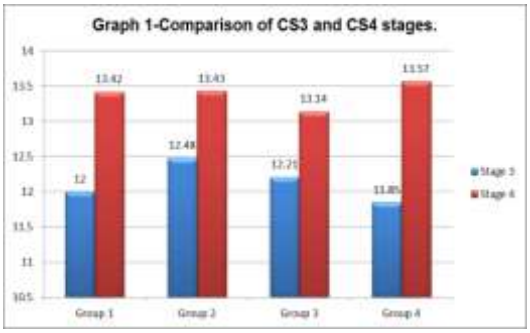

Fig-1: Comparison of CS3 and CS4 stages

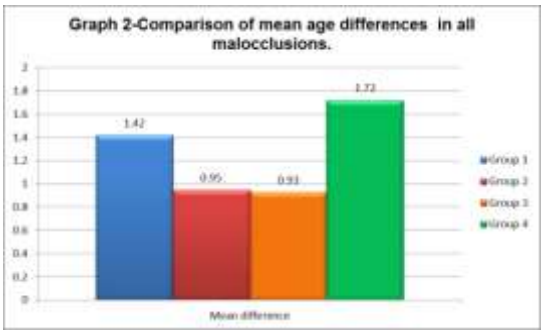

Fig-2: Comparison of mean age differences in all malocclusions

DISCUSSION

Ideal orthodontic treatment timing is during the adolescent growth spurt, which is the late mixed or early permanent dentition with some growth (especially vertical growth) remaining for the treatment, permanent teeth available for the final positioning, as the adolescent growth spurt ends treatment also ends, thus the shorter treatment time lowers the treatment burden [15].

According to the findings of Fishman there was rapid growth velocity up to peak height velocity and then gradual decline. Approximately 50% of total adolescent maxillary and mandibular growth completes at level SIM 6 [12].

In the development of the anteroposterior relationship mandibule plays a major role during puberty, and permanent occlusion is determined during this period. However, there is wide range of variability in amount, direction, velocity, sequence and timings of mandibular growth [17].

The literature provides abundant evidence about the anteroposterior maxillo mandibular relationship of untreated subjects with Class II division 1&division 2 and Class III malocclusion which can worsen during the adolescent growth period, and can affect the treatment timing and stability of treatment outcomes [1, 18].

In a comparision between sexes during puberty, with Class I or II skeletal patterns, mandibular annual growth rate was 2.16 mm for the body length, 3.16 mm for the ramus height, and 4.31 mm for the mandibular length [19].

Alvares and Cancado found out that in post-peak stage of growth, the treatment of Class II malocclusion with the Herbst appliance did not promote any significant changes in the maxilla ,with the effective length increase in the mandible.The maxillary incisors showed retrusion and lingual tipping, while the mandibular incisors exhibited increased protrusion and buccal tipping [23].

Franchi and Pavoni found that treatment done during the pubertal peak was able to produce significant greater increase in mandible length (4.3 mm) and ramus height (3.1 mm) with an advancement of the bony chin (3.9 mm) when compared with the treatment done before puberty [24].

O' Reilly and Yanniello undertook a study and compared Lamparski's stages of growth of cervical vertebrae with mandibular maturation. They found statistica increase in mandibular length, corpus length, and ramus height in association with maturation stages of the cervical vertebrae during puberty [16].

Suk-Cha *et al* evaluated rapid maxillary expansion and facial mask therapy producing skeletal and dentoalveloar changes on Class III malocclusion subjects. The cephalometric study revealed: (1) there was no changes in the maxillary advancement after the protraction therapy in prepubertal growth peak and the pubertal growth peak group, but there was a decrease in the postpubertal growth peak group; (2) there was an increase in the dentoalveolar inclinations in the postpubertal growth peak group; (3) there was no correlation between skeletal age and the postero-inferior rotation of mandible, the increase of lower facial height, and the eruption of maxillary molars [20].

Reyes et al reported about Class III malocclusion subjects, in the pubertal peak had mandibular growth between CVM stages 3 and 4, with average increases in total mandibular length of about 8 and 5.5 mm in Class III boys and girls, respectively [21].

In the current investigation the average chronological age at onset of the pubertal peak was different for all skeletal Class I (average chronological age was12 years), Class II div1 (average chronological age was 12 years 5 months), Class II div 2(average chronological age was 12 years 2 months) and Class III subjects (average chronological age was 11 years 8 months). However, the pubertal growth spurt interval ended earlier for skeletal Class I subjects (average age

of 13 years 4 months), skeletal Class II div 1 subjects (average age of 13 years 4 months), skeletal Class II div 2 subjects (average age of 13 years 1 month) and in skeletal Class III subjects (average age of 13 years 6 months). On average, therefore, the pubertal peak for Class I subjects lasted 1 year 4 months (in agreement with previous indications of the literature) [1,11,22] whereas in subjects with Class II div 1& div 2 malocclusion it lasted for a shorter period (11 months) and Class III malocclusion it lasted for a longer period (1 year 10 months).

The difference in duration was statistically significant. Of course, the results reported in the present study were derived from cross sectional data, and they do not express true longitudinal changes. However, the number of persons comprising the samples at both stages, were highly significant effected the size of the difference in the ‘‘duration’’ of the growth spurt in the four groups, affecting the statistical significance of the outcomes.

The limitation of the study was that, a comparison of male and female pubertal growth spurts was not done, smaller sample size was chosen. In this study only one skeletal maturation indicator was used, so there could be bias, in order to avoid this comparison of two or more skeletal indicators like hand –wrist radiograph etc. should also be done. Furthermore, the study was a cross-sectional one rather than a longitudinal study.

CONCLUSIONS

The average time of onset of pubertal peak in all, Class I, Class II div 1 &2, and Class III subjects is different: 12years, 12 years 5 months, 12 years 2 months and 11 years 8 months respectively.

In Class I subjects, the interval between CS3 and CS4 (duration of pubertal peak) lasts 1 year 4 months, in class II div1 & div 2 subjects 11 months whereas it lasts 1 year 10 months in skeletal Class III malocclusion.

The greater increase in mandibular length in Class III subjects compared to that in Class I subjects during puberty might be associated with the longer duration of the pubertal peak in Class III subjects as reported in the literature.

Duration of pubertal peak in Class I is 5 months longer than class II patients and 6 months shorter than class III patients.

However, further studies on a greater sample size should be conducted on broader aspect, prospective longitudinal studies with better gold standard comparison modes are needed to confirm the usefulness of this technique to accurately determine the timing of a patients growth spurt.

Note

This work was carried out in collaboration between all authors. ‘Samina Khan Mayuri Thomas designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. ‘V. Deepti Reddy managed the analyses of the study. Rawah T Eshky managed the literature searches. All authors read and approved the final manuscript.

Authors Contribution

Dr. V. Deepti Reddy, Dr. Mayuri Thomas, Samina Khan: Concept and research proposal including approval from research ethics committee.

Samina Khan : Procedures and follow ups, Concept, Data analysis and interpretation.

Samina Khan ,**Rawah T. Eshky**: Literature review, Data analysis.

Wamiq Musheer Fareed: Drafting and revision of the manuscript, correspondence.

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