Content available at: https://www.ipinnovative.com/open-access-journals

IP Indian Journal of Orthodontics and Dentofacial Research

Journal homepage: https://www.ijodr.com/

Original Research Article

A comparative cervical verteberal maturity index evaluation of skeletal age in cleft and non-Cleft patients

Anup Kanse[1,*], Abrar Hussain[1], Tulika Tripathi[1], Priyank Rai[1]

[1]*Dept. of Orthodontics, Maulana Azad Institute of Dental Sciences, New Delhi, India*

ARTICLE INFO

Article history:
Received 10-02-2022
Accepted 22-03-2022
Available online 31-03-2022

Keywords:
Cleft lip and palate
Cvmi
Skeletal maturity

ABSTRACT

Introduction: Children with a cleft lip and/or palate (CLP) inherit multiple complications related to inadequate nutrition, feeding problems and speech impairment. Cleft patient treatment aims to address skeletal and dental disharmony through multidisciplinary care, where skeletal discrepancies in children with CLP may require orthopedic and/or surgical correction. It is important to determine the period of accelerated growth of the relevant skeletal structure to achieve the most favourable response with the least potential morbidity.

Materials and Methods: A retrospective study was conducted for a period of eighteen months in which 102 lateral cephalograms of subjects within the age range of nine to eighteen years were examined to evaluate differences in the cervical vertebrae skeletal maturation. Patients with non- syndromic unilateral/bilateral cleft lip and palate and those without cleft and other systemic disorders were analysed.

Results: Fifty-one participants each with and without cleft-palate and lip were recruited in our study. At the age group of 9-13 years, comparison of CVMI status between cleft and non-cleft subjects revealed a statistically significant difference. In the age group of 14 – 18 years, equal distribution was observed in the deceleration stage and maturation stage of cleft and non-cleft groups. More disparity was found in CVMI transition stage**.**

Conclusion: The conducted study indicates statistically significant differences between the skeletal age and chronological age in cleft and non-cleft subjects from the age group of 9-18 years.

1. Introduction

Cleft lip and palate is one of the most common congenital anomaly that occurs in humans. In India, the incidence of cleft lip and or palate ranges from 0.25 to 1.56 per1000 live births.[1] Non-syndromic orofacial clefts, which include cleft lip, cleft lip and palate, and cleft palate alone, comprise a range of disorders affecting the lips and oral cavity, the causes of which remain largely unknown. Effects on speech, hearing, appearance, and cognition can lead to long-lasting adverse outcomes for health and social integration. Affected children need multidisciplinary care from birth until adulthood and have higher morbidity and mortality throughout life than unaffected individuals. Although rehabilitation is possible with good quality care, orofacial clefts inevitably pose a burden to the individual, the family, and society, with substantial expenditure in terms of health and related services.

Care for children born with these defects is multidisciplinary and includes many disciplines such as nursing, plastic surgery, maxillofacial surgery, otolaryngology, speech therapy, audiology, counselling, psychology, genetics, orthodontics, and dentistry but it forms only a part of the clinical load of every area. This fragmentation of care has led to substantial variations

* *Corresponding author*.
E-mail address: anupbkanase@gmail.com (A. Kanse).

https://doi.org/10.18231/j.ijodr.2022.007

in management, which continue to cause controversy. Furthermore, in both developing and developed countries, standards of care for patients with cleft lip, cleft lip and palate, or cleft palate alone remain a cause for concern.[2] Success in dento-facial orthopaedics is highly dependent on the patient's maturational stage. Therefore, it is important to determine the period of accelerated growth of the relevant skeletal structure to achieve the most favourable response with the least potential morbidity.

Hassel and Farman in 1995 compiled a new Cervical Vertebral Maturation index (CVMI) which was based on the morphological changes in the lateral profile of C2, C3, and C4 cervical vertebrae as these areas can be visualized even in presence of a thyroid collar worn during radiation exposure.[3] The advantage of CVMI is that skeletal maturity can be assessed by lateral cephalometric radiograph taken as a part of routine investigation for orthodontic diagnosis and treatment planning. This study was conducted to evaluate differences in the cervical vertebrae skeletal maturation in cleft and non-cleft male and female individuals with respect to age using CVMI staging.

2. Materials and Methods

A retrospective study was conducted at Maulana Azad Institute of Dental Sciences, New Delhi for a period of eighteen months. Hundred and two lateral cephalograms of subjects within the age range of nine to eighteen years were examined to evaluate differences in the cervical vertebrae skeletal maturation. Patients with non-syndromic unilateral/bilateral cleft lip and palate and those without cleft and other systemic disorders were analysed. Lateral cephalograms taken in abnormal neck position, birth defects or those with growth abnormality were excluded from our study. Lateral cephalograms of the selected subjects were mounted on the X-Ray viewer and visual assessment of the skeletal maturity was performed with the Cervical Vertebral Maturation index given by Hassel and Farman.[3] The Cervical Vertebral maturation method constitutes analysing the morphology of the bodies of the second (C2- the odontoid process), third (C3) and the fourth (C4) cervical vertebrae. This includes presence or absence of a concavity at the lower border of the body of C2, C3, and C4 and Shape of the body of C3 and C4. Cervical vertebral maturation stages are distinguished into six stages based on these parameters. (Figure 1)

The chronological age in whole years for each subject was calculated by subtracting date of birth from date on the radiograph. All the lateral cephalograms were divided into cleft and non cleft group. The non cleft group was considered as Group 1 and the cleft group was considered as Group 2. These groups were further subdivided into A and B based on the age range. Subjects from 9 to 13 years were considered as Group A and subjects from 14-18 years of age were considered as Group B. A number was allotted for the subdivided groups for further segregation of males and females (1 for males and 2 for females). (Figure 2)

CVMI-1 (Initiation)	1. Inferior borders of C2, C3, and C4 are flat, wedge shaped. 2. Tapering of the superior vertebral borders from posterior to anterior. 3. 80% to 100% of adolescent growth remains
CVMI-2 (Acceleration)	1. The Inferior borders of C4 is flat. 2. Concavities start developing in the inferior borders of C2 and C3. 3. The bodies of C3 and C4 are more rectangular in shape. 4. 65% to 85% of adolescent growth remains
CVMI-3 (Transition)	1. Distinct concavities are seen in the lower borders of C2 and C3. 2. Concavity developing in the inferior border of C4. 3. The bodies of C3 and C4 are rectangular in shape. 4. 25% to 65% of adolescent growth remains
CVMI-4 (Deceleration)	1. Distinct concavities seen in the inferior borders of C2, C3, and C4. 2. The vertebral bodies of C3 and C4 are nearly square in shape. 3. 10% to 25% of adolescent growth remains
CVMI-5 (Maturation):	1. Accentuated concavities seen in the inferior borders of C2, C3, and C4. 2. The bodies of C3 and C4 are nearly square in shape. 3. 5% to 10% of adolescent growth remains.
CVMI- 6 (Completion)	1. Deep concavities seen in the inferior borders of C2, C3, and C4. 2. The bodies of C3 and C4 are square or greater in vertical dimension than in horizontal dimension. 3. Little or no adolescent growth remains

Intra examiner reliability was tested by randomly selecting 35 lateral cephalometric radiographs and analysing them for skeletal maturation on two separate occasions after a two-week interval. Analysis was done using IBM SPSS Version 16.0. Mean and standard deviation was expressed for quantitative data and percentages for qualitative data. The comparison of CVMI stages for each group was done with Chi-square test. A p-value of less than 0.05 was considered as statistically significant.

3. Results

Fifty-one participants each with and without cleft-palate and lip were recruited in our study. Forty-nine (48%) participants were aged between 9 to 13 years, while 53 (52%) participants were aged between 14 to 18 years.

Fifty-nine (58%) participants were male while 43 (42%) participants were female. The study participants were divided into groups based on age, gender and presence of cleft lip or palate.

At the age group of 9-13 years, comparison of CVMI status between cleft and non-cleft subjects revealed a statistically significant difference. Out of 22 cleft subjects only 1 subject was in CVMI 3 while the others were in CVMI i1 and 2. For the non-cleft group, there was equal distribution of subjects in CVMI 2 and 3. Few subjects were also found to be in CVMI 4 compared to no subjects in cleft group indicating a delay in skeletal maturity.

At the age group of 14-18 years, comparison of CVMI status between cleft and non-cleft subjects revealed a statistically significant difference. Out of 29 cleft subjects 6 subjects were in CVMI 3 while only 1 subject was found in CVMI 3 of the non-cleft group. Equal distribution was observed in the CVMI 4 and 5 of cleft and non-cleft groups. More disparity was found in CVMI 3.

Comparison of cleft and non-cleft males at the age range of 9-13 years showed that the skeletal maturation of non-cleft (Group 1 male) and cleft (Group2 male) subjects was statistically significantly different (p value <0.05). Six subjects of the cleft group (1A1) were found to be in initiation stage compared to no subject of the non-cleft group (2A1) in initiation. While nine subjects of the non-cleft group were found to be in transition stage compared to no subject of the cleft group. Comparison of cleft and non-cleft females at the age range of 9-13 years showed that the skeletal maturation of non-cleft (Group 1 male) and cleft (Group 2 male) subjects was statistically significantly different (p value <0.05). Three subjects of the non-cleft group were found to be in Deceleration stage compared to no subject of the cleft group in initiation. While six subjects of the cleft group were found to be in acceleration stage compared to three subjects were found in the non-cleft group.

An overall statistically significant difference in the CVMI stages of Group 1 and Group 2 subjects was observed between 9-18 years of age. There was a statistically significant difference in the CVMI stages of Group 1 and Group 2 subjects between 9-13 years of age. Results revealed that in the transition stage 91.7% of subjects were in the non-cleft group whereas only 8.3% of subjects were found in the cleft group showing a delay in skeletal maturation. The comparison of CVMI stages of Group 1 and Group 2 for both males and females between 14-18 years of age was statistically insignificant. The comparison of CVMI stages of Group 1 and Group 2 for males was statistically significantly different whereas the comparison for females was statistically insignificant. There was a statistically significant difference in the CVMI stages of Group 1 and Group 2 for males between 9-13 years of age. Transition stage 100% of subjects were in non-cleft group compared to no subjects in the cleft group. There was a statistically significant difference in the CVMI stages of Group 1 and Group 2 for females between 9-13 years of age. Results revealead that in deceleration stage 100% of subjects were in non-cleft group compared to no subjects in the cleft group. The difference in the CVMI stages of Group 1 and Group 2 males and females between 14-18 years of age was statistically insignificant.

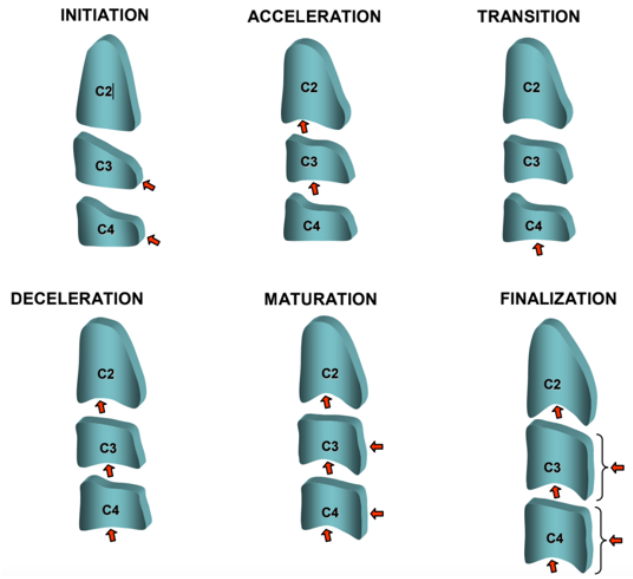

Fig. 1:

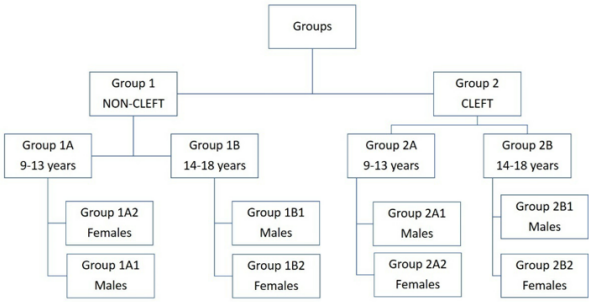

Fig. 2:

4. Discussion

Assessment of skeletal age is part of the biological age assessment and is vital to orthodontic treatment planning. One of the most important issues related to cleft individuals is their skeletal maturation patterns. There are substantial growth impairments and skeletal disproportions associated with the CLP anomaly.[4–6] Maxillary retrusion, class III skeletal disproportion, and crossbites (anterior and/or posterior) are common findings in CLP patients.[5] In order

Table 1: Distribution of study participants based on age and sex.

Distribution of study participants	**No. of cases (%)**
• **Group 1**: Non-cleft subjects.	51 (50.0%)
• **Group 1A**: 9 to 13 years of age	
1A1—Males	16 (15.7%)
1A2—Females	11 (10.8%)
• **Group 1B**: 14 to 18 years of age	14 (13.7%)
1B1—Males **1B2**—Females	10 (9.8%) 51 (50.0%)
• **Group 2**: Subjects with cleft lip and palate	
• **Group 2A**: 9 to 13 years of age	
2A1— Males	12 (11.8%)
2A2— Females	10 (9.8%)
• **Group 2B**: 14 to 18 years of age	
2B1—Males	17 (16.7%)
2B2—Females	12 (11.8%)

Table 2: Mean and standard deviation of age in the various groups

	N	**Mean+/-SD**
Group 1A	27	11.07+1.49
Group 1B	24	15.75+1.42
Group 2A	22	11.09+1.41
Group 2B	29	15.96+1.52

Table 3: Mean and standard deviation of age in various CVMI stages across all groups

	Mean+/-SD			
	Group 1A	**Group 1B**	**Group 2A**	**Group 2B**
CVMI 1	9	-	9.77+0.97	-
CVMI 2	10.1+0.99	-	11.91+ 0.79	-
CVMI 3	12.09+0.83	14	-	13.83+0.40
CVMI 4	12.66+0.57	14.75+1.03	-	15.36+0.50
CVMI 5	-	16.4+1.24	-	17.5+0.79
CVMI 6	-		-	-

Table 4: Comparison of skeletal maturation between Group 1 and Group 2.

Maturation stage	**Count % within maturation stage**			**Chi-square value**	**P value**
	Group 1	**Group 2**	**Total**		
CVMI 1	3 (25%)	9 (75%)	12 (100%)		
CVMI 2	10 (45.5%)	12 (54.5%)	22 (100%)		
CVMI 3	12 (63.2%)	7 (36.8%)	19 (100%)		
CVMI 4	11 (50%)	11 (50%)	22 (100%)	4.831	0.035
CVMI 5	15 (55.6%)	12 (44.4%)	27 (100%)		
CVMI 6	0 (0%)	0 (0%)	0 (0%)		
Total	51 (50%)	51 (50%)	102 (100%)		

Table 5: Comparison of skeletal maturation between Group 1A and Group 2A

Maturation stage	**Count % within maturation stage**			**Chi-square value**	**P value**
	Group 1A	**Group 2A**	**Total**		
CVMI 1	3 (25%)	9 (75%)	12 (100%)		
CVMI 2	10 (45.5%)	12 (54.5%)	22 (100%)		
CVMI 3	11 (91.7%)	1 (8.3%)	12 (100%)		
CVMI 4	3 (100%)	0 (0%)	3 (100%)	14.152	0.003
CVMI 5	0 (0%)	0 (0%)	0 (0%)		
CVMI 6	0 (0%)	0 (0%)	0 (0%)		
Total	27 (55.1%)	22 (44.9%)	49 (100%)		

Table 6: Comparison of skeletal maturation between Group 1B and Group 2B

Maturation stage		Count % within maturation stage			Chi-square value	P value
		Group 1B	Group 2B	Total		
CVMI 1	n	0	0	0	3.942	0.139
	%	0.0	0.0	0.0		
CVMI 2	n	0	0	0		
	%	0.0	0.0	0.0		
CVMI 3	n	1	6	7		
	%	14.3	85.7	100.0		
CVMI 4	n	8	11	19		
	%	42.1	57.9	100.0		
CVMI 5	n	15	12	27		
	%	55.6	44.4	100.0		
CVMI 6	n	0	0	0		
	%	0.0	0.0	0.0		
Total	n	24	29	53		
	%	45.3	54.7	100.0		

Table 7: Comparison of skeletal maturation between Group 1 Females and Group 2 Females.

Maturation stage		Count % within maturation stage			Chi-square value	P value
		Group 1 Females	Group 2 Females	Total		
CVMI 1	n	3	3	6.0	3.956	0.412 NS
	%	50.0	50.0	100.0		
CVMI 2	n	3	6	9.0		
	%	33.3	66.7	100.0		
CVMI 3	n	2	5	7.0		
	%	28.6	71.4	100.0		
CVMI 4	n	6	5	11.0		
	%	54.5	45.5	100.0		
CVMI 5	n	7	3	10.0		
	%	70.0	30.0	100.0		
CVMI 6	n	0	0	0.0		
	%	0.0	0.0	0.0		
Total	n	21	22	43.0		
	%	48.8	51.2	100.0		

Table 8: Comparison of skeletal maturation between Group 1 Males and Group 2 Males

Maturation stage		Count % within maturation stage			Chi-square value	P value
		Group 1 Males	Group 2 Males	Total		
CVMI 1	n	0	6	6	11.546	0.021 S
	%	0.0	100.0	100.0		
CVMI 2	n	7	6	13		
	%	53.8	46.2	100.0		
CVMI 3	n	10	2	12		
	%	83.3	16.7	100.0		
CVMI 4	n	5	6	11		
	%	45.5	54.5	100.0		
CVMI 5	n	8	9	17		
	%	47.1	52.9	100.0		
CVMI 6	n	0	0	0		
	%	0.0	0.0	0.0		
Total	n	30	29	59		
	%	50.8	49.2	100.0		

Table 9: Comparison of skeletal maturation between Group 1A1 and Group 2A1.

Maturation stage		Count % within maturation stage			Chi-square value	P value
		Group 1A1	Group 2A1	Total		
Initiation	n	0	6	6	14.808	0.001 S
	%	0.0	100.0	100.0		
Acceleration	n	7	6	13		
	%	53.8	46.2	100.0		
Transition	n	9	0	9		
	%	100.0	0.0	100.0		
Declaration	n	0	0	0		
	%	0.0	0.0	0.0		
Maturation	n	0	0	0		
	%	0.0	0.0	0.0		
Completion	n	0	0	0		
	%	0.0	0.0	0.0		
Total	n	16	12	28		
	%	57.1	42.9	100.0		

Table 10: Comparison of skeletal maturation between Group 1A2 and Group 2A2.

Maturation stage		Count % within maturation stage			Chi-square value	P value
		Group 1A2	Group 2A2	Total		
Initiation	n	3	3	6	4.295	0.043 S
	%	50.0	50.0	100.0		
Acceleration	n	3	6	9		
	%	33.3	66.7	100.0		
Transition	n	2	1	3		
	%	66.7	33.3	100.0		
Declaration	n	3	0	3		
	%	100.0	0.0	100.0		
Maturation	n	0	0	0		
	%	0.0	0.0	0.0		
Completion	n	0	0	0		
	%	0.0	0.0	0.0		
Total	n	11	10	21		
	%	52.4	47.6	100.0		

Table 11: Comparison of skeletal maturation between Group 1B1 and Group 2B1.

Maturation stage		Count % within maturation stage			Chi-square value	P value
		Group 1B1	Group 2B1	Total		
Initiation	n	0	0	0	0.195	0.907 NS
	%	0.0	0.0	0.0		
Acceleration	n	0	0	0		
	%	0.0	0.0	0.0		
Transition	n	1	2	3		
	%	33.3	66.7	100.0		
Declaration	n	5	6	11		
	%	45.5	54.5	100.0		
Maturation	n	8	9	17		
	%	47.1	52.9	100.0		
Completion	n	0	0	0		
	%	0.0	0.0	0.0		
Total	n	14	17	31		
	%	45.2	54.8	100.0		

Table 12: Comparison of skeletal maturation between Group 1B2 and Group 2B2.

Maturation stage		Count % within maturation stage			Chi-square value	P value
		Group 1B2	Group 2B2	Total		
Initiation	n	0	0	0		
	%	0.0	0.0	0.0		
Acceleration	n	0	0	0		
	%	0.0	0.0	0.0		
Transition	n	0	4	4		
	%	0.0	100.0	100.0		
Declaration	n	3	5	8	5.968	0.051 NS
	%	37.5	62.5	100.0		
Maturation	n	7	3	10		
	%	70.0	30.0	100.0		
Completion	n	0	0	0		
	%	0.0	0.0	0.0		
Total	n	10	12	22		
	%	45.5	54.5	100.0		

to correct these discrepanices assessment of growth status is important to predict their growth potential. Only a few studies have addressed skeletal maturation in CLP participants in comparison with a control population and their findings are limited to the gender and ethnicity studied.[7–9] A study by Ross et al 1987reported that the skeletal age is retarded in cleft children and the cleft children are shorter and lighter than that of control children.[10]

The authors suggested the reason for height-weight retardation to be due to feeding problems and heightened frequency of infections.[11] Some investigators have suggested that this diminution resulted from events in adolescence (endocrine controls of maturation at puberty) and not the result of feeding difficulties, infections, or surgical interventions experienced in the months immediately following birth.[12]Rudman and Davis et al found that heights of cleft children to be below the 3rd percentile for that age group and suggests that children with cleft lip or cleft palate are forty times more likely to experience growth hormone deficiency than the non-cleft children. These studies emphasize the importance of treatment timing in cleft individuals.[13]

In the current study, the collected sample consisted of age matched cleft and non-cleft subjects ranging from 9 to 18 years. This ensured equal distribution age wise, which helped accurately identify the pubertal growth spurt in both groups. The results of the present study showed that the cleft subjects had a delay in skeletal maturity compared to non-cleft subjects, irrespective of the gender. Bowers and Rosario et al found that specifically males with unilateral cleft lip and palate and isolated cleft palate were significantly shorter and thinner (reduced Body Mass Index) than normal, whereas females with isolated cleft palate differed from normal only in their shorter height.[14]

At the age of 9-13 years, girls with UCLP are observed to attain skeletal maturation faster than boys with UCLP of similar age. Sun and Li reported similar significant difference in cleft boys where the authors observed that boys with cleft lip and or palate were at a higher risk of delayed growth period and retarded pubertal growth peak.[9] In another study conducted by Sun and Li assessed the skeletal maturation in Chinese females with cleft and noticed a delay in skeletal maturity in cleft patients.

Comparison of cleft and non-cleft males and females at the age range of 14-18 years showed that the skeletal maturation of non-cleft (Group 1 male) and cleft (Group 2 male) subjects was not statistically significantly different. The present study showed that children with UCLP of 14 to 18 years of age group, irrespective of the gender showed faster rate of skeletal maturation than non-cleft children, but the difference was statistically insignificant.

The findings of the study also suggest that in 9 to 13 years age group there is delay in skeletal maturation among children with cleft; where as in 14 to 18 years age group skeletal maturation was found to be comparable among children with cleft and non-cleft children. Possible reason could be the adolescent catch-up growth seen among the cleft children. The total growth period is longer among cleft children and thus they are able to catch up with the normal control group.

Our study included 9 to 18 year old participants with an outcome that indicated a highly statistically significant difference between the skeletal maturation of cleft and non-cleft subjects at the age range of 9-13 years confirming that participants with the cleft anomaly are more likely to have a decelerated pubertal spurt and a delayed pubertal peak. This proved the implication of cleft anomalies in growth patterns, which has been proposed by many investigators.[4,15]

5. Conclusion

Cleft patient treatment aims to address skeletal and dental disharmony through multidisciplinary care, where skeletal

discrepancies in children with CLP may require orthopedic and/or surgical correction· Generally, orthodontic treatment and intervention are timed to take place before or during the peak growth velocity or pubertal growth spurt to achieve favorable effects in correcting sagittal, transverse, and vertical plane disharmonies. In this study our aim was to evaluate differences in the cervical vertebrae skeletal maturation in cleft and non-cleft male and female individuals with respect to age. The conducted study indicates statistically significant differences between the skeletal age and chronological age in cleft and non-cleft subjects from the age group of 9-18 years.

6. Conflict of Interest

None.

7. Source of Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

1. Suri S, Utreja A. Institutional Approach in the Management of Cleft Lip and Palate ; 2000.
2. WHO Human Genetics Programme. Global strategies to reduce the health-care burden of craniofacial anomalies: report of WHO meetings on international collaborative research on craniofacial anomalies. Geneva: World Health Organization; 2002.
3. Hassel B, Farman AG. Skeletal maturation evaluation using cervical vertebrae. *Am J Orthod Dentofacial Orthop*. 1995;107(1):58–66.
4. Montagnoli LC, Barbieri MA, Bettiol H, Marques IL, De Souza L. Growth impairment of children with different types of lip and palate clefts in the first 2 years of life: a cross-sectional study. *J Pediatr (Rio J)*. 2005;81(6):461–5. doi:10.2223/JPED.1420.
5. Gaggl A, Feichtinger M, Schultes G, Santler G, Pichlmaier M, Mossböck R, et al. Cephalometric and occlusal outcome in adults with unilateral cleft lip, palate, and alveolus after two different surgical techniques. *Cleft Palate Craniofac J*. 2003;40(3):249–55.
6. Marques IL, Nackashi JA, Borgo HC, Martinelli A, Pegoraro-Krook MI, Williams WN, et al. Longitudinal study of growth of children with unilateral cleft-lip palate from birth to two years of age. *Cleft Palate Craniofac J*. 2009;46(6):603–9.
7. Soegiharto BM, Cunningham SJ, Moles DR. Skeletal maturation in Indonesian and white children assessed with hand-wrist and cervical vertebrae methods. *Am J Orthod Dentofacial Orthop*. 2008;134(2):217–26.
8. Sun L, Li WR. Cervical vertebral maturation of female children with orofacial clefts. *Cleft Palate Craniofac J*. 2013;50(5):535–41.
9. Sun L, Li WR. Cervical vertebral maturation of children with orofacial clefts. *Cleft Palate Craniofac J*. 2012;49(6):683–8.
10. Ross RB. Treatment variables affecting facial growth in complete unilateral cleft lip and palate. *Cleft Palate J*. 1987;24(1):5–77.
11. Shi B, Losee JE. The impact of cleft lip and palate repair on maxillofacial growth. *Int J Oral Sci*. 2015;7(1):14–7.
12. Ingalls TH, Taube IE, Klingberg MA. Cleft lip and cleft palate: epidemiologic considerations. *Plast Reconstr Surg*. 1964;34:1–10. doi:10.1097/00006534-196407000-00001.
13. Rudman D, Davis GT, Priest JH, Patterson JH, Kutner MH, Heymsfield SB, et al. Prevalence of growth hormone deficiency in children with cleft lip or palate. *TJ Pediatr*. 1978;93(3):378–82.
14. Bowers EJ, Mayro RF, Whitaker LA, Pasquariello PS, Larossa D, Randall P, et al. General body growth in children with clefts of the lip, palate, and craniofacial structure. *Scand J Plast Reconstr Surg Hand Surg*. 1987;21(1):7–14.
15. Marcelino E, Tavano O, De Carvalho IM. Cervical vertebrae as growth and development estimator in cleft lip/palate patients. *Salusvita*. 2005;24(1):21–8.

Author biography

Anup Kanse, Professor

Abrar Hussain, Post Graduate

Tulika Tripathi, Senior Professor and Head

Priyank Rai, Senior Professor

Cite this article: Kanse A, Hussain A, Tripathi T, Rai P. A comparative cervical verteberal maturity index evaluation of skeletal age in cleft and non-Cleft patients. *IP Indian J Orthod Dentofacial Res* 2022;8(1):38-45.