Research Article

A COMPARATIVE STUDY OF CROWN/ROOT RATIO BETWEEN UNILATERAL AND BILATERAL CLP PATIENTS AND CONTROL GROUP

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ARTICLE INFO	ABSTRACT
	Context: It is observed that cleft lip and palate (CLP) patients have more dental abnormalities than individuals without cleft such as hypodontia, supernumerary teeth, microdontia, reduced crown and root size, etc. Anticipated implications of vertical distortion, reported from panoramic radiographs, could be prevented when assessing crown/root ratio of CLP patients [16]. **Aims:** To compare crown root ratio of cleft patient with normal patients so as to modify orthodontic treatment mechanics **Methods and Material:** Digital orthopantomograms of cleft patients and control patients were obtained from the department. Crown/Root ratios were calculated for 50 CLP patients (25 Bilateral CLP and 25Unilateral CLP patients) and 32control group patients from orthopantomograms. A total of 2045 teeth (1224teeth of CLP patients, 821 teeth of control patients) were traced and measured. **Results:** BCLP patients have significantly higher C/R ratio in some teeth than UCLP. Root length is shorter in BCLP than UCLP group. **Conclusions:** orthodontic treatment modification in biomechanics, using lighter forces and periodic check-up for root resorption for CLP patients should be considered.

INTRODUCTION

Cleft lip and palate (CLP) accounts for a large fraction of all human birth defects and are notable for their significant lifelong morbidity and complex aetiology[1].

It has been suggested that cleft lip and palate is not just a localized disruption in development but is a systemic, generalized restriction of these individuals' growth potential[2]. It can be caused by a single gene mutation, chromosomal aberration or specific environmental agents but majority is caused by interaction of many genetic and environmental factors[2].

Cleft not only interferes with feeding, respiration and various other physical and psychological functions but is also partially responsible for the observed reduction in the growth potential. The variation in abnormalities from one patient to another patient makes the problem difficult to define and evaluate[3,4]. Children with CLP require various health care practitioners who form a cleft team. This multidisciplinary CLP team comprises of Paediatrician, Plastic surgeon, Orthodontist, Ear Nose Throat surgeons, Speech therapist, Psychologists etc. This team is responsible for patients' medical and general development, facial esthetics, psychological wellbeing, hearing and speech development. Orthodontist forms the key part of this multidisciplinary effort[5].

It is observed that CLP patients have more dental abnormalities than individuals without cleft. This includes hypodontia, supernumerary teeth, microdontia, aberrant root forms, malformed teeth, reduced crown and root size, pseudoprognathism etc[5]. These defects may be attributed to cleft itself or to early surgical correction of defects.

Increased incidence of dental crown abnormalities associated with CLP have been reported by several investigators. These abnormalities affect both upper and lower arches; anterior and posterior teeth[6]. Similarly several studies have been carried out to assess root development in cleft patients. However, most of these were focused on root development of the lateral incisor in the vicinity of the cleft[5,7,8].

The morphologic events associated with tooth root formation in variety of animals have been described; however, mechanism of human tooth root formation is not completely understood[9,10]. The main reasons for short dental roots can be disturbances

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during root development or resorption of developed roots[12] Some type of environmental insults during tooth development were found to result in short rooted teeth. They include chemotherapy, radiation therapy, etc. They have also been associated with Steven-Johnson Syndrome, Down Syndrome, Turner Syndrome, scleroderma [11] etc. short root anomaly as described by a few others is not due to the resorption of roots but due to developmentally short blunt roots of teeth particularly, the maxillary incisor teeth[13,14]. Roots of teeth are usually measured on panoramic radiographs. Several studies have demonstrated that accurate reproducibility of panoramic radiograph and their diagnostic quality are heavily dependent on careful attention to positioning and processing[15,]. Anticipated implications of vertical distortion, reported from panoramic radiographs, could be prevented when assessing crown/root ratio of CLP patients [16].

Therefore, this study is undertaken to compare crown root ratio of cleft patient with control group so as to modify orthodontic treatment mechanics as short roots resulting in highly unfavourable crown root ratio may affect the prognosis of teeth and complicate Orthodontic treatment planning[17].

The aims and objectives of this study are

- To define and compare crown root ratio of permanent teeth of both unilateral and bilateral cleft patients to control group patients.
- To define and compare crown root ratio of permanent teeth between bilateral and unilateral cleft patients.
- To determine and compare crown height and root length of permanent teeth between unilateral and bilateral cleft patients and to control group patients so as to assist orthodontist in treatment planning.

SUBJECTS AND METHODS

Pretreatment digital orthopantomograms of cleft patients and control patients were obtained from the department. The study sample consisted of 47CLP patients undergoing orthodontic treatment with age group of 14 to 22 years (mean age 17 years) wherein 23 were bilateral cleft lip and palate (BCLP) and 24 were unilateral cleft lip and palate (UCLP) and 32 control group patients with the mean age of 14-22 years (mean age 17 years).

Cleft subjects with following criteria were considered for this study

- Unilateral or Bilateral complete cleft.
- Not having any other recognizable syndrome.
- Age more than 14 years with all permanent teeth erupted excluding third molars.
- The Pretreatment Orthopantogram of the patients undergoing orthodontic treatment at the department of orthodontics, Government Dental College and Hospital, Ahmedabad. All the patients included in the study presented were undergoing orthodontic treatment for the first time i.e. on history taking no history of prior orthodontic treatment was provided by the patients included in the study.

Control group subjects were included with following criteria.

- Age more than 12 years – All permanent teeth erupted excluding third molars.
- Normal Class I occlusion with no crowding or spacing.
- Not having any dental or skeletal anomaly.
- No history of orthodontic treatment in past.

Digital orthopantomograms of all the patients were obtained from Kodak 8000 c machine (France) with exposure time 13.9 seconds at 10 mA and 72 kVp to avoid error of magnification of images. These digital orthopantomograms were traced under ideal conditions, including the use of subdued lights, film masking, and a conventional viewing box. The outlines of the permanent maxillary and mandibular teeth which were apparent, were marked with a special pencil (0.5mm lead). Crown heights and root lengths were measured using the method of Lind[14] (Figure 1-8), and the measurements were made with a sliding digital Vernier callipers on acetate sheet. All the measurements were rounded to the nearest tenth decimal.

For the purposes of tooth length measurements, three parallel reference lines were drawn and crown height and root length of all the teeth were measured.

- An incisal / occlusal reference line - A tangent to an incisal tip or a buccal cusp and visually placed perpendicular to the long axis of the tooth.
- The cervical reference line - the line joining the mesial and distal cervical margins of enamel.
- The apical reference line touching the outermost part of the root, and in teeth with two buccal roots, the longer root was measured; this line was visually placed perpendicular to the long axis of the tooth[14]. The palatal roots of the maxillary molars were omitted.
- Crown height - measured by drawing the perpendicular line from the midpoint of the cervical reference line to the incisal/occlusal reference line with the help of digital Vernier calliper.
- Root length - measured by the perpendicular line from the midpoint of the cervical reference line to the apical reference line with the help of Digital Vernier Calliper.
- The C/R ratio of an individual tooth - calculated by dividing crown height by root length.

Teeth were excluded if

- They showed obvious distortion,
- The apex was not closed,
- Root resorption was evident,
- They were impacted,
- Marked attrition or abrasion of the crown
- Teeth showing pulpal or periapical lesion
- Grossly carious teeth,
- Teeth with morphologic developmental anomalies.

The data thus obtained was subjected to statistical analyses.
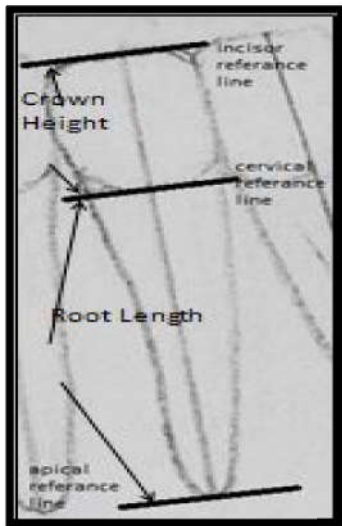
Figure 1 Measurement of crown-height and root length using the method of Lind[24]

Figure 2 Sample Orthopantomogram of control patients

Figure 3 Sample Orthopantomogram of BCLP patient

Figure 4 Sample Orthopantomogram of UCLP patient
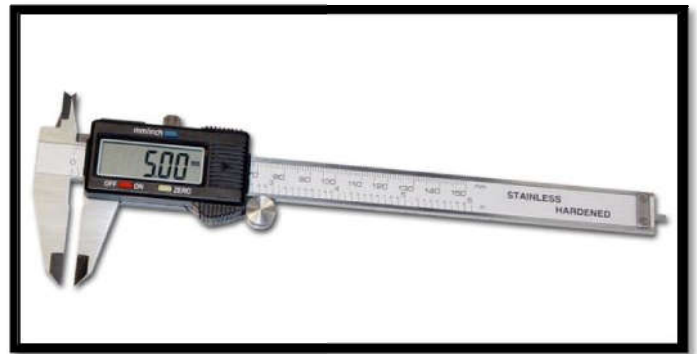
Figure 5 - Digital vernier caliper
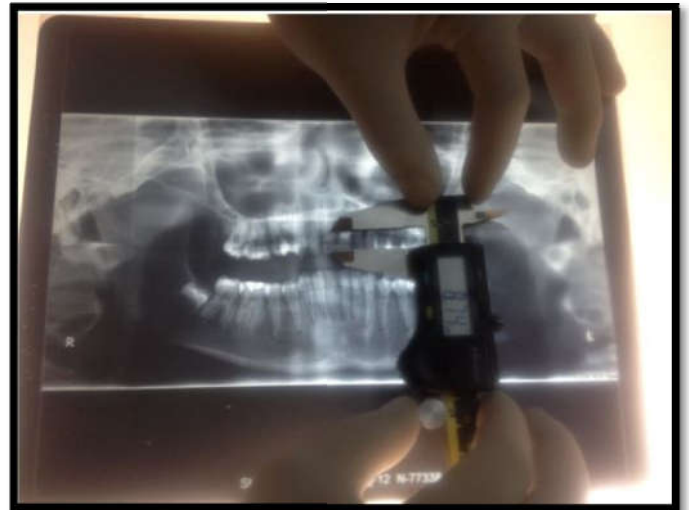
Figure 6 Procedure to measure crown height and root length
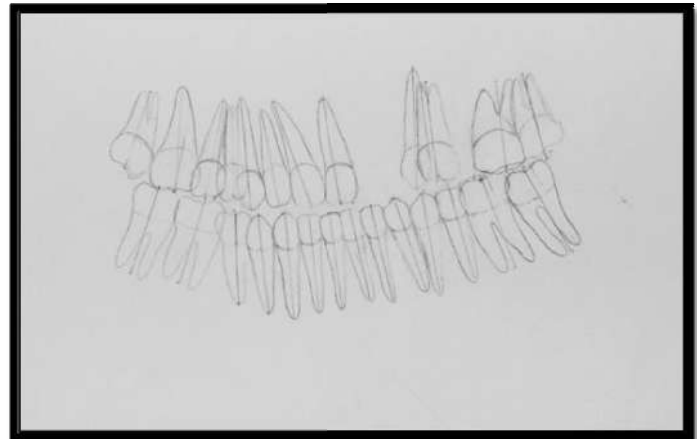
Figure 7 - Tracing on acetate sheet

Figure 8 A sample Orthopantomogram used in the study with tracing

RESULTS AND DISCUSSION

Digital orthopantomograms of cleft and control group patients were used to measure crown heights and root lengths. Crown /Root ratios were calculated for 47 CLP patients (23 BCLP and 24 UCLP) and 32 control group patients. A total of 2045 teeth (1224 teeth of CLP patients, 821 teeth of controls patients) were traced and measured and the data thus obtained was subjected to statistical analyses. The missing and impacted teeth were not traced in from the CLP patients sample. 3 teeth were excluded as they showed severe dilacerations and the apical 1/3rd of the root curved excessively in relation to the long axis of the tooth. These teeth were excluded because of the fact that the straight line measurement from the tip of the root to the cervical reference line of the tooth would not reflect the actual root length of the tooth.

Statistical analysis

The statistical methods that were employed in the present study are:
Mean
Standard deviation
Standard error
Independent samples T test
P – value

On the basis of study, Table-1 shows the difference in mean crown-root (C/R) ratio between control with UCLP and control with BCLP patients.

It was observed that statistically significant difference existed in Maxillary Central Incisors (p= 0.043), Maxillary Lateral Incisors (p = 0.029), Mandibular Central Incisors (p= 0.042) and Mandibular Lateral Incisors (p= 0.032) when control group was compared with UCLP group. When control group was compared with BCLP group, following teeth showed statistically significant difference.[Maxillary central incisors (p= 0.001), maxillary lateral incisors (p=0.039), maxillary canines (p= 0.019), maxillary first premolars (p= 0.035), maxillary second premolars (p= 0.002) and maxillary second molars (p= 0.001), mandibular central incisors (p=0.004), mandibular lateral incisors (p= 0.036), mandibular canines (p=0.044) and mandibular first premolars (p=0.005)]. These findings are similar to those of Ghaida A. Al Jamal *et al* [18], where control group compared with UCLP, showed significant difference in C/R ratio of maxillary and mandibular incisors. C/R ratio of control group when compared with BCLP, showed significant difference in maxillary incisors, maxillary canines, maxillary premolars, maxillary second molars, mandibular incisors, mandibular canines and mandibular first premolars. In contrast our study shows maxillary second premolar to have a highly significant variation (p= 0.002). C/R ratios are higher for both BCLP and UCLP patients than in controls. It is also noticed that C/R ratios of canines, premolars, and molars in both jaws are not affected when UCLP is compared with control group. This unfavourable C/R ratio could be the result of shorter roots rather than longer crowns in CLP patients.

Table 1 Difference in mean Crown-Root ratio between control and unilateral cleft lip and palate patients, control and bilateral cleft lip and palate patients.

	Control				Unilateral cleft lip and palate						Bilateral cleft lip and palate					
	N	Mean C/R ratio	s.d	s.e	N	mean	s.d	s.e	P value		N	Mean C/R ratio	s.d.	s.e.	P value	
11,21	59	0.70	0.12	0.02	43	0.72	0.14	0.04	S[a]	0.043	44	0.91	0.20	0.06	S[c]	0.001
12,22	55	0.63	0.10	0.02	22	0.70	0.14	0.04	S[a]	0.029	17	0.80	0.14	0.05	S[a]	0.039
13,23	55	0.68	0.11	0.02	38	0.71	0.15	0.04	NS	0.999	41	0.84	0.19	0.06	S[a]	0.019
14,24	53	0.67	0.07	0.01	39	0.65	0.15	0.04	NS	0.871	42	0.78	0.15	0.05	S[a]	0.035
15,25	52	0.68	0.08	0.02	39	0.64	0.13	0.04	NS	0.504	46	0.82	0.09	0.03	S[b]	0.002
16,26	60	0.75	0.12	0.02	45	0.77	0.12	0.03	NS	0.905	54	0.92	0.22	0.07	NS	0.107
17,27	58	0.78	0.12	0.02	41	0.85	0.15	0.04	NS	0.994	46	1.03	0.28	0.09	S[c]	0.001
31,41	58	0.59	0.09	0.02	43	0.68	0.11	0.03	S[a]	0.042	52	0.72	0.14	0.04	S[b]	0.004
32,42	58	0.60	0.08	0.02	46	0.68	0.12	0.03	S[a]	0.032	54	0.70	0.14	0.04	S[a]	0.036
33,43	56	0.62	0.09	0.02	43	0.64	0.10	0.03	NS	0.320	53	0.67	0.13	0.04	S[a]	0.044
34,44	56	0.59	0.08	0.02	42	0.70	0.15	0.04	NS	0.130	52	0.72	0.08	0.03	S[b]	0.005
35,45	57	0.56	0.07	0.02	42	0.64	0.10	0.03	NS	0.520	52	0.68	0.13	0.04	NS	0.092
36,46	60	0.60	0.09	0.02	46	0.65	0.12	0.03	NS	0.418	51	0.76	0.16	0.05	NS	0.087
37,47	57	0.66	0.12	0.02	40	0.68	0.16	0.05	NS	0.889	51	0.79	0.12	0.04	NS	0.077

[a] → p ≤ 0.05, [b] → p ≤ 0.01, [c] → p ≤ 0.001
C/R indicates crown-root; s, significant; ns, not significant; s.d, standard deviation; s.e, standard error; n, number of teeth.
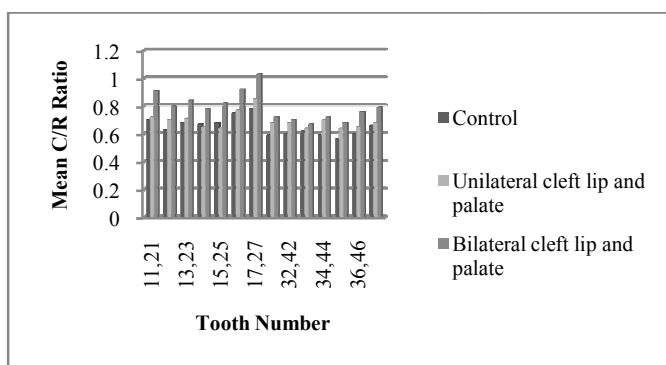
But very few studies have been conducted which investigate crown / root ratios, crown height and root length in CLP patients to be available for comparison.

Table 2 shows the difference in mean C/R ratio between BCLP and UCLP patients. Within the CLP group, BCLP patients showed high and statistically significant C/R ratios in the following teeth [maxillary central incisors (p = 0.01), maxillary lateral incisors (p=0.02), maxillary canines (p = 0.04), maxillary second premolars (p = 0.002), maxillary first molars (p = 0.043) and maxillary second molars (p = 0.014)]. This is in contrast to study by Ghaida Al Jamal *et al* [18] who found comparable C/R ratio of maxillary anterior teeth between BCLP and UCLP patients.

Table 2 Difference in mean Crown-Root ratio between Bilateral cleft lip and palate and Unilateral cleft lip and palate patients.

Tooth	Bilateral cleft lip and palate				Unilateral cleft lip and palate				Mean Difference	P value	
	N	Mean C/R ratio	s.d	s.e	N	Mean C/R ratio	s.d	s.e			
11,21	44	0.91	0.20	0.06	43	0.72	0.14	0.04	0.19	0.010	S[b]
12,22	17	0.80	0.14	0.05	22	0.70	0.14	0.04	0.17	0.022	S[a]
13,23	41	0.84	0.19	0.06	38	0.71	0.15	0.04	0.15	0.047	S[a]
14,24	42	0.78	0.15	0.05	39	0.65	0.15	0.04	0.14	0.053	NS
15,25	46	0.82	0.09	0.03	39	0.64	0.13	0.04	0.18	0.002	S[b]
16,26	54	0.92	0.22	0.07	45	0.77	0.12	0.03	0.15	0.043	S[a]
17,27	46	1.03	0.28	0.09	41	0.85	0.15	0.04	0.24	0.014	S[a]
31,41	52	0.72	0.14	0.04	43	0.68	0.11	0.03	0.05	0.030	S[a]
32,42	54	0.70	0.14	0.04	46	0.68	0.12	0.03	0.02	0.039	S[a]
33,43	53	0.67	0.13	0.04	43	0.64	0.10	0.03	0.03	0.881	NS
34,44	52	0.72	0.08	0.03	42	0.70	0.15	0.04	0.02	0.695	NS
35,45	52	0.68	0.13	0.04	42	0.64	0.10	0.03	0.04	0.449	NS
36,46	51	0.76	0.16	0.05	46	0.65	0.12	0.03	0.11	0.077	NS
37,47	51	0.79	0.12	0.04	40	0.68	0.16	0.05	0.10	0.109	NS

[a] → $p \leq 0.05$, [b] → $p \leq 0.01$, [c] → $p \leq 0.001$

C/R indicates crown-root; s, significant; ns, not significant; s.d, standard deviation; s.e, standard error; n, number of teeth.
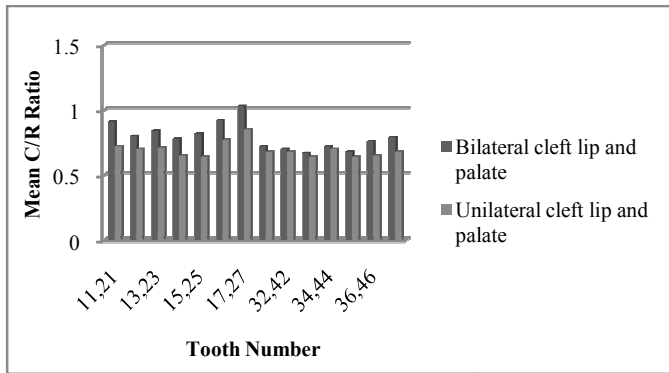
Mandibular central incisors (p = 0.030) and mandibular lateral incisors (p = 0.039) showed statistically significant higher C/R ratio in BCLP than UCLP patients. These findings are in concurrence with Ghaida Al Jamal *et al* [18].

Table 3 shows difference in mean crown heights of all teeth between cleft and control patients. With regard to crown height comparison in control and cleft group, statistically significant

lesser crown height is found in CLP group for maxillary first premolars(p = 0.042), maxillary second premolars (p = 0.035), maxillary first molars (p = 0.024) and mandibular second premolars (p = 0.037). However mandibular central incisors (p = 0.041), mandibular lateral incisors (p = 0.022), have statistically significant greater crown heights in the CLP group. The crowns of some teeth are significantly shorter, but those of other teeth are significantly longer in CLP patients than in control patients. CLP patients having enamel defects and abnormalities in shape and size of both deciduous and permanent teeth are more common than in normal patients. This explains the deviation in crown height from normal in the CLP group. A study by Akcam MO *et al* [19](2008) showed that crown height measurements in the casts of CLP patients were smaller than those of controls not only in the affected maxillary dental arch, but also in the mandibular dental arch. It is important, however, to be aware that study methods varied, in that investigators used casts rather than radiographic assessments. Table 4 shows that all the maxillary teeth except maxillary second premolars and maxillary first molars showed shorter root length in CLP group which was statistically significant.[maxillary central incisors (p=0.027), maxillary lateral incisors (p=0.042) and maxillary canines (p=0.037),

Table 3 Difference in mean crown heights of all teeth between cleft and control patients.

Tooth	Control				Cleft				P value	
	N	Mean Crown height (mm)	s.d	s.e	N	Mean Crown height (mm)	s.d	s.e		
11,21	59	8.74	1.50	0.27	87	8.11	1.09	0.22	NS	0.078
12,22	55	8.11	1.35	0.24	39	7.97	1.81	0.43	NS	0.085
13,23	55	10.22	1.13	0.20	79	10.05	1.51	0.32	NS	0.091
14,24	53	8.53	1.03	0.19	81	7.94	1.25	0.27	S[a]	0.042
15,25	52	8.49	1.05	0.20	85	8.13	1.05	0.22	S[a]	0.035
16,26	60	9.30	0.91	0.16	99	8.25	1.16	0.24	S[a]	0.024
17,27	58	8.59	0.90	0.16	87	8.21	1.12	0.24	NS	0.098
31,41	58	7.07	0.86	0.16	95	8.34	1.08	0.22	S[a]	0.041
32,42	58	7.29	0.76	0.14	100	8.48	0.96	0.19	S[a]	0.022
33,43	56	9.43	1.04	0.18	96	9.76	1.08	0.22	NS	0.102
34,44	56	8.13	1.01	0.18	94	8.35	1.03	0.22	NS	0.121
35,45	57	8.20	0.95	0.17	94	7.89	1.16	0.24	S[a]	0.037
36,46	60	8.28	1.00	0.18	97	8.03	1.48	0.30	NS	0.121
37,47	57	8.30	1.01	0.18	91	8.25	1.13	0.24	NS	0.078

[a] → $p \leq 0.05$, [b] → $p \leq 0.01$, [c] → $p \leq 0.001$

s.d, standard deviation; s, significant; ns, not significant; s.e, standard error; n, number of teeth.

maxillary first premolars (p=0.036), maxillary second molars(p=0.029), mandibular central incisors (p=0.033), mandibular lateral incisors (p=0.041), mandibular first molars (p=0.014)].

Table 4 Difference in mean root length of all teeth between cleft and control patients

Tooth	Control				Cleft				P value	
	N	Mean root length (mm)	s.d	s.e	N	Mean root length (mm)	s.d	s.e		
11,21	59	15.66	1.98	0.35	87	14.40	2.45	0.50	Sa	0.027
12,22	55	14.98	1.97	0.35	39	13.46	2.21	0.52	Sa	0.042
13,23	55	18.89	2.58	0.46	79	16.25	2.24	0.47	Sa	0.037
14,24	53	15.23	1.69	0.32	81	12.65	2.10	0.46	Sa	0.036
15,25	52	15.10	1.86	0.35	85	11.95	2.22	0.47	NS	0.359
16,26	60	14.10	1.43	0.25	99	12.98	1.87	0.38	NS	0.674
17,27	58	13.98	1.61	0.29	87	13.05	2.53	0.54	Sa	0.029
31,41	58	13.22	1.68	0.30	95	11.91	2.27	0.46	Sa	0.033
32,42	58	14.23	1.67	0.30	100	13.13	2.42	0.49	Sa	0.041
33,43	56	17.42	2.11	0.37	96	15.52	2.04	0.42	NS	0.877
34,44	56	16.92	1.70	0.30	94	15.65	1.70	0.36	NS	0.161
35,45	57	16.10	1.94	0.35	94	15.96	1.70	0.35	NS	0.094
36,46	60	16.28	1.85	0.33	97	15.73	1.96	0.39	Sa	0.014
37,47	57	16.12	1.48	0.27	91	15.39	2.38	0.52	NS	0.256

a → p ≤ 0.05,   b → p ≤ 0.01,   c → p ≤ 0.001
s.d, standard deviation; s.e, standard error; n, number of teeth; s, significant; ns, not significant.
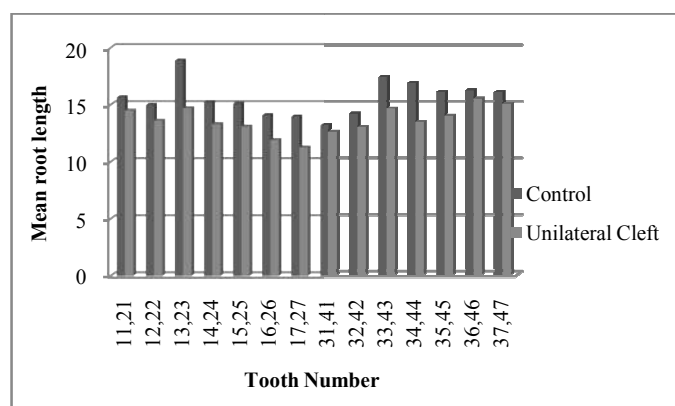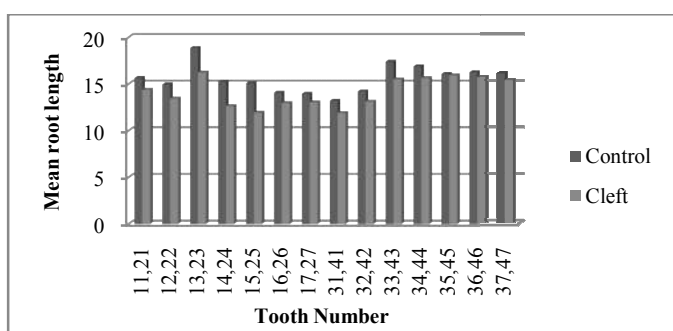
Demirjian's study[20] concluded that mechanisms controlling dental development are independent of somatic and sexual maturity and are highly influenced by the same etiologic factor as the cleft, because some types of environmental insults during tooth development and genetic factors may result in short-rooted teeth. CLP patients should be considered as potentially having short roots, resulting in unfavourable C/R ratios and may influence the treatment results. This is in concurrence with the study by Al- Jamal GA *et al* [18] (2010) and Weihua Zhou *et al* [21] (2013), who observed that unfavourable C/R ratio in cleft could be due short root length in some teeth and that it is more pronounced in BCLP than in UCLP patients.

Table 5 shows that maxillary central incisors (p=0.016), maxillary lateral incisors (p=0.024) and mandibular central incisors (p=0.029), mandibular lateral incisors (p=0.049) in UCLP patients have statistically significant shorter roots than those in control group. Though statistically not significant, the rest of the teeth in both the arches show shorter roots in UCLP patients as compared to control group of patients. This again leads us to believe that some genetic influence and environmental insults during formation of roots may be responsible. Table 6 shows that maxillary central incisors (p=0.049), maxillary lateral incisors (p=0.027), maxillary canines (p=0.033), maxillary first premolars

Table 5 Difference in mean root length of all teeth between control and Unilateral cleft lip and palate patients.

Tooth	Control				Unilateral Cleft				P value	
	N	Mean root length (mm)	s.d	s.e	N	Mean root length (mm)	s.d	s.e		
11,21	59	15.66	1.98	0.35	43	14.50	2.06	0.29	Sa	0.016
12,22	55	14.98	1.97	0.35	22	13.61	2.51	0.38	Sa	0.024
13,23	55	18.89	2.58	0.46	38	14.70	1.89	0.27	NS	0.231
14,24	53	15.23	1.69	0.32	39	13.31	1.76	0.26	NS	0.124
15,25	52	15.10	1.86	0.35	39	13.09	1.69	0.24	NS	0.221
16,26	60	14.10	1.43	0.25	45	11.91	1.45	0.21	NS	0.196
17,27	58	13.98	1.61	0.29	41	11.26	2.33	0.34	NS	0.291
31,41	58	13.22	1.68	0.30	43	12.63	2.06	0.29	Sa	0.029
32,42	58	14.23	1.67	0.30	46	13.02	2.26	0.31	Sa	0.049
33,43	56	17.42	2.11	0.37	43	14.67	2.17	0.31	NS	0.679
34,44	56	16.92	1.70	0.30	42	13.50	1.94	0.28	NS	0.387
35,45	57	16.10	1.94	0.35	42	14.05	1.61	0.23	NS	0.315
36,46	60	16.28	1.85	0.33	46	15.56	1.93	0.27	NS	0.408
37,47	57	16.12	1.48	0.27	40	15.09	2.23	0.33	NS	0.857

a → p ≤ 0.05,   b → p ≤ 0.01,   c → p ≤ 0.001
s.d, standard deviation; s.e, standard error; n, number of teeth; s, significant; ns, not significant.

(p=0.045), maxillary second premolars (p=0.016), maxillary second molars (p=0.037) and in mandibular teeth, mandibular

central incisors (p=0.027), mandibular lateral incisors (p=0.044), mandibular canines (p=0.047), mandibular first premolars (p=0.039) in BCLP patients have statistically significant shorter roots than those in control group. This may be due to the fact that the teeth around the cleft are more affected and that BCLP has an increased deformity than UCLP.

Table 7 shows that maxillary first premolars (p=0.034), maxillary second premolars (p=0.048), maxillary first molars (p=0.027), mandibular central incisors (p=0.019), mandibular lateral incisors (p=0.016), mandibular second premolars (p=0.012) showed significantly shorter crown heights in UCLP than in control group.

Table 6 Difference in mean root length of all teeth between control and Bilateral cleft lip and palate patients.

Tooth	Control				Bilateral Cleft				P value	
	N	Mean root length (mm)	s.d	s.e	N	Mean root length (mm)	s.d	s.e		
11,21	59	15.66	1.98	0.35	44	13.80	2.19	0.32	S[a]	0.049
12,22	55	14.98	1.97	0.35	17	12.86	1.61	0.30	S[a]	0.027
13,23	55	18.89	2.58	0.46	41	14.91	1.96	0.30	S[a]	0.033
14,24	53	15.23	1.69	0.32	42	12.98	2.14	0.32	S[a]	0.045
15,25	52	15.10	1.86	0.35	46	12.86	1.90	0.29	S[a]	0.016
16,26	60	14.10	1.43	0.25	54	11.13	1.87	0.26	NS	0.182
17,27	58	13.98	1.61	0.29	46	10.98	2.53	0.39	S[a]	0.037
31,41	58	13.22	1.68	0.30	52	11.84	2.12	0.31	S[a]	0.027
32,42	58	14.23	1.67	0.30	54	12.53	2.34	0.33	S[a]	0.044
33,43	56	17.42	2.11	0.37	53	14.07	1.60	0.23	S[a]	0.047
34,44	56	16.92	1.70	0.30	52	13.21	1.26	0.18	S[a]	0.039
35,45	57	16.10	1.94	0.35	52	13.83	1.69	0.24	NS	0.101
36,46	60	16.28	1.85	0.33	51	15.20	1.67	0.24	NS	0.067
37,47	57	16.12	1.48	0.27	51	15.04	2.33	0.36	NS	0.078

[a] → p ≤ 0.05, [b] → p ≤ 0.01, [c] → p ≤ 0.001
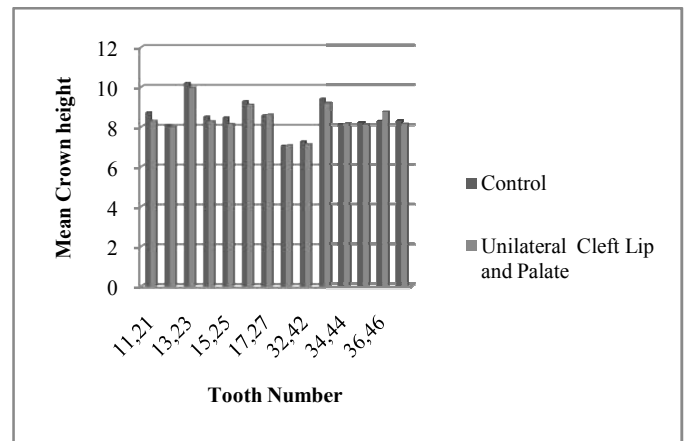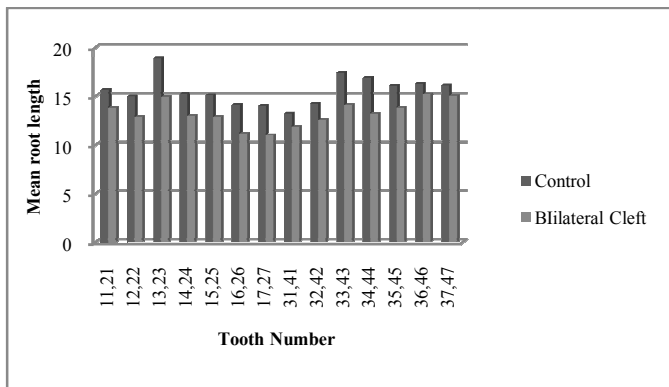s.d, standard deviation; s.e, standard error; n, number of teeth; s, significant; ns, not significant

Table 7 Difference in mean crown heights of all teeth between control and Unilateral cleft lip and palate patients.

Tooth	Control				Unilateral Cleft				P value	
	N	Mean Crown height (mm)	s.d	s.e	N	Mean Crown height (mm)	s.d	s.e		
11,21	59	8.74	1.50	0.27	43	08.32	1.20	0.17	NS	0.060
12,22	55	8.11	1.35	0.24	22	08.01	1.82	0.28	NS	0.069
13,23	55	10.22	1.13	0.20	38	9.97	1.37	0.20	NS	0.065
14,24	53	8.53	1.03	0.19	39	8.30	1.23	0.19	S[a]	0.034
15,25	52	8.49	1.05	0.20	39	8.16	1.32	0.19	S[a]	0.048
16,26	60	9.30	0.91	0.16	45	9.12	1.28	0.18	S[a]	0.027
17,27	58	8.59	0.90	0.16	41	8.64	1.24	0.19	NS	0.144
31,41	58	7.07	0.86	0.16	43	7.10	1.26	0.18	S[a]	0.019
32,42	58	7.29	0.76	0.14	46	7.15	1.05	0.15	S[a]	0.016
33,43	56	9.43	1.04	0.18	43	9.20	1.08	0.16	NS	0.074
34,44	56	8.13	1.01	0.18	42	8.15	1.12	0.16	NS	0.064
35,45	57	8.20	0.95	0.17	42	8.11	1.21	0.18	S[a]	0.012
36,46	60	8.28	1.00	0.18	46	8.75	1.44	0.20	NS	0.151
37,47	57	8.30	1.01	0.18	40	8.14	1.49	0.23	NS	0.207

[a] → p ≤ 0.05, [b] → p ≤ 0.01, [c] → p ≤ 0.001
s.d, standard deviation; s.e, standard error; n, number of teeth;
s, significant; ns, not significant

With regards to crown height comparisons, the results were somehow inconsistent in that the tooth crowns were shorter in some cleft patients and longer in some cleft patients.

Table 8 Difference in mean crown heights of all teeth between control and Bilateral cleft lip and palate patients.

Tooth	Control				Bilateral Cleft				P value	
	N	Mean Crown height (mm)	s.d	s.e	N	Mean Crown height (mm)	s.d	s.e		
11,21	59	8.74	1.50	0.27	44	8.25	2.10	0.30	NS	0.450
12,22	55	8.11	1.35	0.24	17	8.24	1.72	0.32	NS	0.061
13,23	55	10.22	1.13	0.20	41	10.01	1.33	0.20	NS	0.072
14,24	53	8.53	1.03	0.20	42	8.39	1.19	0.18	S[a]	0.020
15,25	52	8.49	1.05	0.20	46	8.31	0.62	0.09	S[a]	0.038
16,26	60	9.30	0.91	0.16	54	9.28	0.82	0.12	S[a]	0.012
17,27	58	8.59	0.90	0.16	46	8.60	1.03	0.16	NS	0.081
31,41	58	7.07	0.86	0.16	52	7.05	0.85	0.12	S[b]	0.010
32,42	58	7.29	0.76	0.14	54	7.25	0.80	0.11	S[a]	0.019
33,43	56	9.43	1.04	0.18	53	9.33	0.98	0.14	NS	0.093
34,44	56	8.13	1.01	0.18	52	8.28	0.88	0.13	NS	0.083
35,45	57	8.20	0.95	0.17	52	8.18	1.00	0.14	S[a]	0.015
36,46	60	8.28	1.00	0.18	51	8.39	1.30	0.18	NS	0.060
37,47	57	8.30	1.01	0.18	51	8.43	0.69	0.10	NS	0.086

[a] → $p \leq 0.05$, [b] → $p \leq 0.01$, [c] → $p \leq 0.001$
s.d, standard deviation; s.e, standard error; n, number of teeth;
s, significant; ns, not significant.
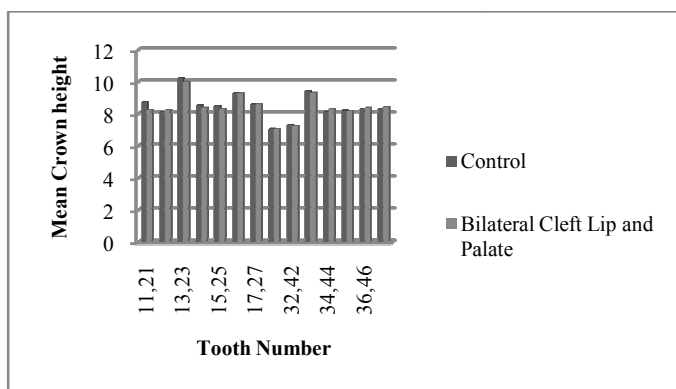
In CLP group enamel defects and abnormalities in size and shape of both deciduous and permanent teeth are far more common than in control group. This explains deviation in crown height and root length from normal [6,10,22].

Summing up above results, it was observed that root lengths and crown heights were altered in CLP group as compared to control group, thereby altering the C/R ratio.

The study compared the crown-root ratio of UCLP, BCLP and control patients. But, there are limitations of orthopantogram like superimposition and distortion. A few teeth had to be excluded in the CLP patients because of dilacerations, impactions or due to missing teeth. Such exclusion may lead to errors in the interpretation of the results as most of the controls did not have similar anomalies. However within these limitations, we observed C/R ratio to be higher in UCLP group as compared to control group and it was even higher in BCLP group than UCLP. Further studies with the use of CBCT (Cone Beam Computed Tomography) can lead to a more accurate representation of assessing the crown-root ratio in the patients with CLP.

CONCLUSION

- BCLP patients have significantly higher C/R ratio in some teeth than UCLP and Control group.

- UCLP patients have significantly higher C/R ratio because of significantly shorter root length in Maxillary and mandibular Incisors than Control group.
- CLP group have similar crown heights and shorter root lengths as compared to control group. Root length is shorter in BCLP than UCLP group.
- Therefore during orthodontic treatment modification in biomechanics, using lighter forces and periodic check-up for root resorption for CLP patients should be considered.
- To avoid error of distortion while measuring crown heights and root lengths, C/R ratio was taken into consideration.

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