CEPHALOMETRIC EVALUATION OF CRANIOFACIAL PATTERN OF NEPALESE PATIENTS WITH CLASS III MALOCCLUSION

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ABSTRACT

Objective: To find out the differences in craniofacial pattern between Class III malocclusion and normal occlusion in Nepalese population.

Materials and Method: Lateral cephalogram of 30 patients with Class III malocclusion (11 male and 19 female; mean age, 17.27 ± 3.88 years) and 30 patients with normal occlusion (15 males and 15 females; mean age: 19.03 ± 4.94 years) were analyzed for various linear and angular measurements. The variables between the two groups were compared using independent *t*- test.

Results: The base angle N-S-Ar was significantly smaller ($P< 0.05$) in Class III group. The relative position of the maxilla in sagittal relation as indicated by angle of convexity (N-A-Pog) and A to N perpendicular was significantly retrusive in Class III group ($P < 0.05$). The length of the maxilla was significantly reduced in Class III group ($P<0.01$). The relative sagittal position of the mandible was significant protrusive in Class III group as indicated by SNB ($P< 0.01$), facial angle (FH to N Pog) ($P<0.05$) and N perpendicular to Pog ($P<0.001$). The upper incisors were proclined and positioned anteriorly ($P<0.01$) in Class III group while the lower incisors were retroclined ($P<0.05$). The upper lip in Class III was retrusive ($P < 0.05$) relative to Ricketts esthetic plane and the nasolabial angle was significantly decreased in Class III groups ($P< 0.01$).

Conclusion: There are significant differences in craniofacial pattern in Class III Nepalese population as compared to normal Nepalese population.

Keywords: *cephalometric analysis, Class III malocclusion, craniofacial pattern, normal occlusion, skeletal combinations*

INTRODUCTION:

Class III malocclusion is a complex problem, it results from combination of various components. There are various number of average morphologic differences observed with a variety of combinations of morphologic traits suggesting that the clinical entity of the Class III skeletal pattern can result from a number of etiologic factors acting alone or in combination.[1]

Previously it was suggested that the mandible plays an etiology of the Class III skeletal pattern. Recent studies have shown that the development of maxilla, length of the cranial base and the position of the glenoid fossa are also responsible for Class III skeletal pattern. Hence the differential diagnosis has become more important during recent years as a result of refinement in orthodontic, orthopaedic, and surgical procedures. For the orthopaedic treatment either on maxilla or mandible, early diagnosis is very important.[2-4] Many studies have shown that Class III malocclusion results from combination of various skeletal entities.

Sanborn found that 45.24% of the sample of adults with Class III malocclusion had mandibular skeletal prognathism with orthognathic maxilla and approximately 33.33% of the sample of patients had maxillary skeletal retrusion with the mandible within the normal range of prognathism. A combination of maxillary skeletal retrusion and mandibular prognathism was observed in

approximately 9.5% of the sample of patients.[5] Williams and Andersen used linear analysis to show that it was the size and position of the maxilla that was responsible for Class III malocclusion.[6]

Guyer et al investigated patients with Class III molar relationship as determined from lateral cephalogram. The patients were of age group 5 to 15 years and were divided into four different groups. The investigation reinforced that Class III malocclusion presents with various skeletal and dental combinations. Twenty five percentage of the total sample had maxillary retrusion and 18.7% had mandibular retrusion while 22.2% of the sample had combination of maxillary retrusion and mandibular protrusion.[7]

Mouakeh in a Syrian population found that 43.5% of the patients with Class III malocclusion had pure maxillary retrusion and 29% had combination of maxillary retrusion and mandibular protrusion while no pure mandibular protrusion was found in any of the skeletal combinations.[8]

The reported prevalence of Class III malocclusion was found to vary among races. It is 3.7% for Nepalese population of eastern Nepal.[9] Although the prevalence of Class III malocclusion is less as compared to other malocclusions, it is important because it has a multiple treatment modalities which are case dependent. The treatment modalities depend on the craniofacial pattern and age of the patient. No studies have previously examined the morphological pattern of Nepalese with Class III malocclusion. The aim of the present study was to find out the craniofacial pattern of Nepalese population with Class III malocclusion and to compare it with normal occlusion group.

MATERIALS AND METHOD:

The material consisted of lateral cephalograms of 30 patients with Class III malocclusion (11 male and 19 female; mean age, 17.27 ± 3.88 years) and 30 patients with normal occlusion (15 males and 15 females; mean age: 19.03 ± 4.94 years). Ethical clearance was obtained from the Institutional Review Board, National Academy of Medical Sciences, Bir hospital and each patient's written consent was obtained for the study.

The patients with Class III malocclusion were selected from the orthodontic treatment files of a private practice at Orthodontic Center, Kathmandu, National Academy of Medical Sciences (NAMS), Bir hospital and Gandaki Medical College and Teaching Hospital, Pokhara. The inclusion criteria for Class III malocclusion group were: (1) Good quality pretreatment lateral cephalograms made on the same cephalostat, (2) Class III relationship of the first permanent molars, determined by clinical evaluation of each patient in centric relation to rule out functional Class III malocclusion, (3) Nepalese ethnicity, (4) No cleft palate or other craniofacial anomaly.

The normal occlusion group was screened from patients, attendants and staffs of National Academy of Medical Sciences, Bir hospital, Kathmandu. The inclusion criteria for normal occlusion group were: (1) normal overbite and overjet, (2) straight to slightly convex profile, (3) Class I relationship of the first permanent molars, determined by clinical evaluation of each sample in centric relation. The exclusion criteria were: (1) proximal dental caries, (2) missing teeth, (3) a history of significant medical illness, and (4) previous orthodontic or prosthodontic treatment. To maintain the uniformity, the lateral cephalograms were made from the same cephalostat in the Orthodontic center, Kathmandu, Nepal.

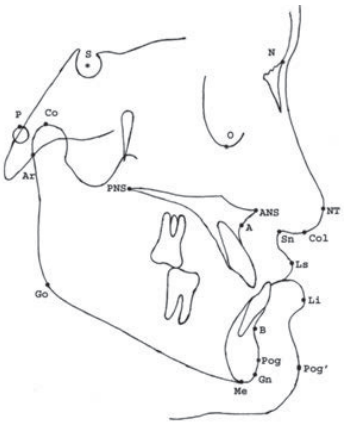

Fig:1 Cephalometric landmarks. N,nasion; S,sella; O,orbitale; P,porion; Co,condylion; Ar,articulare; A,A point; B,B point; ANS,anterior nasal spine; PNS,posterior nasal spine; Go,gonion; Pog,pogonion; Gn,Gnathion; Me,menton; NT,nasal tip; Col,collumella; Sn,subnasale; Ls,labiale superius; Li,Labiale inferius; Pog',soft tissue pogonion.

Lateral cephalograms were traced onto acetate papers and landmarks placed by the same investigator (Figure 1). Linear parameters were measured with a vernier caliper and angular parameters with a protractor, which recorded up to 0.01 mm and 0.5 degree, respectively.

The 31 linear and angular parameters were measured (Table 1).[10-17] The data were entered in SPSS program version 16.0. Independent *t*-tests were performed to assess the differences between the Class III group and control subjects. The level of significance used was a probability value of less than 0.05. Independent *t*-test and Chi-square test were used to assess the distribution of age and sex amongst the two groups respectively. The analysis of various skeletal component combinations was done.

For the purpose of testing the intra-investigator error, 20 cephalograms were retraced after 2 months by same investigator. The readings were analyzed using paired *t*-test and, Lin's concordance method for any significant difference between the two tracings.[18]

RESULTS:

No statistical significant differences were found between observations made at two different times for the purpose of error testing using paired *t*-test and Lin's concordance coefficient (Table 2).Mean age was 17.27 years (± 3.88 years) for Class III malocclusion and 19.03 years (± 4.94 years) for Class I group. The age and the sex distribution

Table 1. Linear and angular cephalometric measurements used in present study						
Cranial base	**Maxillary skeletal**	**Mandibular skeletal**	**Intermaxillary skeletal**	**Dentoalveolar**	**Facial heights**	**Soft tissue analysis**
S-N(mm)	SNA(°)	SNB(°)	ANB(°)	U1/L1(°)	Lower anterior facial height;ANS-Me(mm)	Upper lip to E-plane (distance between upper lip and NT-Pog')
S-Ar(mm)	Convexity(°)	Facial Angle(°)	Wits apprasial(mm)	U1/NA(°)	Anterior facial height ;N-Me(mm)	Lower lip to E-plane (distance between lower lip and NT-Pog')
N-S-Ar(°)	A to N perp(mm)	MP/FH(°)	Mx-Md diff(mm)	U1/NA(mm)	Posterior facial height;S-Go(mm)	Nasolabial angle(col-sn-ls)
	Co-A(mm)	Ar-Go-Me(°)	PP/MP(°)	L1/NB(°)		
	PP-FH(mm)	Co-Gn(mm)		L1/NB(mm)	Jarabak's ratio	
		Pog to N perp(mm)				
		Y-axis(°)				

of samples in the two groups were comparable (P>0.05). The mean and standard deviations of linear and angular cephalometric variables of the Class III malocclusion and Class I normal occlusion groups are presented in Table 3.

Cranial base relationship

The base angle N-S-Ar was significantly smaller (P< 0.05) in Class III group.

Maxillary skeletal relationship

The relative position of the maxilla in sagittal relation as indicated by angle of convexity (N-A-Pog) and N ⌊ A was significantly retrusive in Class III group (P < 0.05). The length of the maxilla was significantly shorter (P < 0.05) in case of Class III group as indicated by effective maxillary length (Co-A).

Mandibular skeletal relationship

The mandible as indicated by SNB, facial angle (FH to NPog) and N ⌊ Pog was protrusive in Class III group (P< 0.05).

Interskeletal relationship

The ANB and Wits were significantly smaller in Class III group (P<0.05). The maxillo-mandibular difference was significantly greater in Class III group (P<0.05).

Dentoalveolar relationship

The maxillary incisors were significantly proclined and anteriorly positioned as evaluated relative to NA line (P<0.05). The mandibular incisors in Class III group relative to NB line were retrusive and anteriorly positioned (P<0.05). The interincisal angle was significantly obtuse in Class III group (P<0.05).

Facial Height

The posterior facial height (S-Go) was significantly (P< 0.05) decreased in Class III group. The anterior facial (N-Me), lower anterior facial height (ANS-Me) and Jarabak's ratio were not significantly different between the two groups.

Soft tissue

The upper lip in relation to Rickett's esthetic plane (LS-E) was significantly (P<0.05) retrusive in Class III group. The lower lip in relation to Rickett's esthetic plane (LI-E) was in normal position. The nasolabial angle was significantly (P<0.05) reduced in Class III group.

Analysis of component combinations

The frequencies with which the various skeletal component combinations occurred in the Class III group were determined. A neutral range for individual measures of maxillary and mandibular skeletal positions and vertical facial dimension was established from the Class I group. The neutral range for N ⌊ A, facial angle (NPog to FH) and lower anterior facial height (ANS-Me) were determined.

The values less than the neutral range indicated a retrusive position for the maxilla or mandible and short lower anterior facial height while the values greater than the neutral range indicated a protrusive position of maxilla or mandible or long lower anterior facial height. Every individual value could then be classified as low, neutral, or high.

Skeletal components

From the 3 trichotomies; maxillary skeletal position, mandibular skeletal positions and vertical facial dimension, 27 combinations were possible. In our sample of Class III group, 10 out of 27 combinations occurred (Table 4).

The most prevalent combination represented group 1 and 2. The percentage of prevalence was 16.67% for each group. Group 1 represented retrusive maxilla, protrusive mandible and normal lower anterior facial height while Group 2 represented those patients in Class III with normal maxilla, protrusive mandible and normal lower anterior facial height. The next frequent group was Group 3 (13.33%) with protrusive maxilla, protrusive mandible and neutral lower anterior facial height.

Table 2. Summary Table for the Error of Study Analyses (n=20)		
Variable	**Lin's Concordance Correlation Pc**	**Paired *t*-test (two tailed *P* value)**
S-N	0.988	0.643
S-Ar	0.988	0.725
N-S-Ar	0.965	0.192
SNA	0.969	1.000
Convexity	0.996	0.507
N perp A	0.991	0.057
Co-A	0.993	0.225
PP-FH	0.993	0.068
SNB	0.994	0.107
Facial Angle	0.986	0.878
Md/FH	0.995	0.591
Ar-G-Me	0.980	0.056
Co-Gn	0.989	0.810
N perp Pog	0.996	0.186
Y-axis	0.977	0.902
ANB	0.988	0.083
Witts	0.994	0.398
MxMd Diff	0.994	0.102
PP-Md	0.994	0.412
Interincisal	0.991	0.574
U1/NA angular	0.995	0.148
U1/NA linear	0.954	0.479
L1/NB angular	0.955	0.240
L1/NB linear	0.989	0.606
ANS-Me	0.987	0.330
Ant facial height	0.997	0.056
Posterior facial height	0.993	0.144
Jarabak's ratio	0.990	0.055
LS-E plane	0.992	0.577
LI-E plane	0.985	0.815
Nasolabial angle	0.897	0.263

Maxillomandibular components

In order to find out the combinations of maxilla and mandible only irrespective of lower anterior facial height 9 possible combinations occurred. Out of 9 possible combinations only 6 occurred in our sample of Class III patients (Table 5). The frequently occurring combination was Group 1 (26.67%) which represented Class III samples with neutral maxilla and protrusive mandible. The next frequent was Group 2 (23.33%) which represented retrusive maxilla and neutral mandible. Ten percent of patients (Group 5) amongst Class III showed neutral maxilla and mandible.

DISCUSSION:

Class III malocclusion does not follow a typical facial skeletal pattern. Various types of skeletal combinations are associated with Class III malocclusion.[5] The present study was done to find out the morphological craniofacial pattern of Nepalese Class III population and to compare it with the Nepalese Class I population.

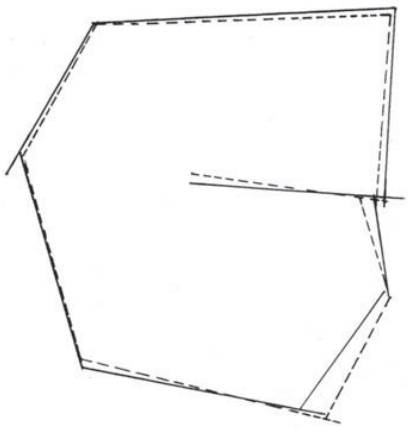

Fig :2 Composite polygon of Class III malocclusion group (dotted line) and normal occlusion group (solid line).

Table 3. Cephalometric measurement analysis of Class III and normal occlusion groups						
	Class III malocclusion group		Class I normal occlusion group			
Cephalometric measures	Mean	SD	Mean	SD	*P* value	Sig
Cranial base						
S-N	70.70	4.17	72.85	4.30	0.05	NS
S-Ar	35.12	3.86	36.12	3.29	0.285	NS
N-S-Ar	119.55	6.812	124.15	5.17	0.005	*
Maxillary Skeletal						
SNA	81.86	4.17	83.20	2.57	0.150	NS
Convexity	-10.70	6.23	3.55	5.63	0.000	*
N perp A	-4.63	4.18	-1.80	3.71	0.007	*
Co-A	86.28	6.50	93.56	5.41	0.000	*
PP-FH	6.52	7.23	5.08	5.90	0.404	NS
Mandibular Skeletal						
SNB	86.32	4.25	81.03	3.02	0.000	*
Facial Angle	90.05	4.18	86.65	3.33	0.001	*
MP/FH	24.78	5.16	22.23	5.29	0.064	NS
Ar-G-Me	125.17	6.49	118.90	5.30	0.107	NS
Co-Gn	123.63	8.57	123.20	5.19	0.814	NS
N perp Pog	0.97	6.9	-5.58	5.83	0.000	*
Y-axis	59.40	4.45	60.37	3.90	0.375	NS
Inter-Skeletal						
ANB	-4.67	3.39	2.55	1.85	0.000	*
Witts	-9.28	4.06	1.05	2.66	0.000	*
Mx-Md Diff	37.35	6.69	29.70	3.85	0.000	*
PP-Md	21.31	6.07	19.48	5.37	0.220	NS
Dentoalveolar relationship						
Interincisal angle	132.18	11.50	126.43	8.86	0.034	*
U1/NA angular	30.85	7.03	23.88	5.85	0.000	*
U1/NA linear	8.85	3.51	6.38	2.04	0.002	*
L1/NB angular	21.65	7.34	27.02	5.77	0.003	*
L1/NB linear	4.93	2.58	6.27	2.37	0.042	*
Facial height						
ANS-Me	67.50	5.85	68.87	5.21	0.344	NS
Ant facial height	119.90	7.31	123.30	6.46	0.061	NS
Posterior facial height	82.97	5.68	86.98	5.23	0.006	*
Jarabak's ratio	69.33	4.98	70.645	4.32	0.278	*
Soft tissue						
LS-E plane	-5.23	2.52	-4.00	2.18	0.048	*
LI-E plane	-1.12	2.80	-1.96	2.46	0.217	NS
Nasolabial angle	85.73	15.05	101.33	9.36	0.000	*
Sig indicates significance; *P<0.05; NS: not significant						

Table 4. The Ten Combinations of Horizontal and Vertical Maxillary and Mandibular Skeletal Components found in the Class III Sample (Out of 27 possible combinations)

Group	N	Maxilla (SNA)	Mandible (Facial angle)	LAFH	%
1	5	←	→	=	16.67
2	5	=	→	=	16.67
3	4	→	→	=	13.33
4	3	←	=	=	10.00
5	3	←	=	↓	10.00
6	3	←	=	=	10.00
7	3	=	=	=	10.00
8	2	→	→	↓	6.67
9	1	=	→	↑	3.33
10	1	=	→	↓	3.33

Table 5. Six Combinations of Horizontal Maxillary and Mandibular Components found in the Class III Sample (Out of 9 possible combinations)

Groups	N	Maxilla (SNA)	Mandible (Facial Angle)	%
1	8	=	→	26.67
2	7	←	=	23.33
3	6	→	→	20
4	5	←	→	16.67
5	3	=	=	10
6	1	→	=	3.33

This study suggested that in Nepalese Class III population the Saddle angle (N-S-Ar) is decreased which was suggestive of a reduced flexure of the cranial base in patients with Class III malocclusion. This finding is in agreement with that of Bjork who indicated that in Class III malocclusion, the abnormality lies in the cranial base.[19] The anterior cranial base (N-S) and posterolateral cranial base (S- Ar) in Class III Nepalese population was comparable with Class I population. This result are in contrary to that of the Syrian population in whom the anterior cranial base (N-S) and posterolateral cranial base (S-Ar) are decreased in Class III group.[8] The maxilla was retrusive in Class III group as suggested by the angle of convexity and N ⊥ A. The length of the maxilla was less in Class III group as indicated by the effective maxillary length (Co-A). The maxillary length was 5-6 mm shorter in Class III malocclusion. These findings are consistent with that reported by Miyajima in Asian population and Mouakeh in Syrian population.[8,20] All these authors suggest that hypoplastic midface and deficient maxillary development are the main factor for Class III malocclusion.

The mandible was significantly anteriorly positioned in Class III population as indicated by SNB, facial angle (FH – NPog) and N ⊥ Pog (Figure 2). These findings are consistent with the study done by Guyer et al and Chang.[7, 21]

There was no increase in the effective mandibular length; it was comparable with that of the normal Class I population. There was no significant difference in the Y axis between the two groups which was consistent with the finding of Sanborn.[5]

There was a significant difference in the inter-skeletal relationship; this was indicated by negative ANB angle, negative Wits value and significant difference between the effective maxillary and mandibular length in Class III samples. The retrusive position, decreased length of maxilla and anterior position of mandible were the causative factor for the interskeletal difference rather than the increased length of the mandible.

The maxillary incisors were significantly proclined where as the lower incisors were significantly retroclined. This could be attributed to dentoalveolar compensation for interskeletal discrepancy. This result is consistent with the study done by Hyung et al in Korean children.[22] The findings of Chang et al contradicts with these results who reported patients in which both upper and lower incisors were retroclined.[21]

In our study, the upper lip was retrusive (LS- E plane) in Class III population where as the lower lip position (LI-E plane) was not different amongst the two groups. The nasolabial angle was significantly smaller in Class III group. These findings are consistent with the findings of Hyung et al in Korean children who also found retruded upper lip and smaller nasolabial angle.[22]

The skeletal component combinations in our study had two groups which were more common. The first group was with maxillary retrusion, mandibular protrusion with neutral lower anterior facial height which is approximately 16.67%. This is slightly less than that shown by Guyer et al who found this combination in approximately 22 % of patients with Class III.[7] The second group with similar

percentage (16.67%) was with normal maxillary length, increased mandibular length and neutral lower anterior facial height.

In our study, pure mandibular skeletal protrusion occurred in 26.67% of the Class III population. This is higher than the study by Guyer et al who found 20%-22% of population with pure mandibular protrusion and is less than that studied by Sanborn and Jacobson et al in permanent dentition.[7, 5, 23]

CONCLUSION:

The results of this study showed that the major craniofacial difference between Nepalese Class I population and Class III population were as follows:

- There was a reduced flexure of the cranial base.
- Maxilla was retrusive and significantly smaller.
- The mandible in Class III was positioned anteriorly in sagittal plane whereas the length of the mandible was same as that of Class I group.
- The maxillary incisors were more protrusive while the mandibular incisors were slightly retrusive.
- The upper lip was retrusive and the lower lip was in normal position
- The nasolabial angle was decreased in Class III group.

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