THREE DIMENSIONAL ANALYSIS OF PHARYNGEAL AIRWAY OF SUBJECTS WITH SURGICALLY REPAIRED UNILATERAL AND BILATERAL CLEFT LIP AND PALATE

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By

Dr. RAHUL KUMAR ANAND

Under the guidance of

DR. TRIPTI TIKKU

Professor and Head
Department of Orthodontics and Dentofacial Orthopaedics

BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES, LUCKNOW
(Faculty of Babu Banarasi Das University)

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Date:

Place: LUCKNOW

Dr. Rahul Kumar Anand

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Date:

Dr.Tripti Tikku

Professor and Head

Department of Orthodontics and Dentofacial Orthopaedics

BBDCODS, BBDU

Lucknow

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CO-GUIDES

Dr. Rohit Khanna
Professor
B.B.D.C.O.D.S
Lucknow

Dr. Rana Pratap Maurya
Reader
B.B.D.C.O.D.S
Lucknow

Dr. Kamna Srivastava
Reader
B.B.D.C.O.D.S
Lucknow

Dr. Veerendra Prasad
Asst. professor
KGMC, Lucknow

ENDORSEMENT BY THE HOD / HEAD OF THE INSTITUTION

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Dr. Tripti Tikku

Professor and Head

Department of Orthodontics

& Dentofacial Orthopaedics

B.B.D.C.O.D.S., BBDU

LUCKNOW

Dr. B. Rajkumar

Principal

Professor and Head

Department of conservative dentistry

and Endodontics

B.B.D.C.O.D.S., BBDU

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Place:

Dr. Rahul Kumar Anand

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Dr. Srishti Aditi

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S.NO	ABBREVIATIONS	FULL FORM
1.	TS	Tuberculum Sellae
2.	DS	Dorsum Sellae
3	MS	Microsoft
4.	AN	Adenoid-Nasopharynx
5.	ST	Sella turcica
6.	Na	Nasion
7.	Ba	Basion
8.	C2	Anterior most point of second cervical vertebrae
9.	PNS	Posterior nasal spine
10.	Ad	Posterior most point of soft tissue Adenoid
11.	Ad’	Anterior most point of soft tissue Adenoid
12.	Sc	Center of Sella turcica

ABSTRACT

AIM AND OBJECTIVE:- The aim of the study was to evaluate the dimensional changes in sella turcica and flexion of cranial base secondary to nasopharyngeal obstruction due to enlarged adenoids and to find correlation between dimensional changes in sella turcica with flexion angle of cranial base.

MATERIAL AND METHOD:- A total of 100 lateral cephalograms of pre-treated patients with age ranging from 9 to 15 years were taken and equally divided in two groups. Group I comprised of lateral cephalograms of patients with normal sized adenoids whereas Group II comprised of lateral cephalograms of patients with enlarged adenoids. A total of 11 parameters were taken into consideration to evaluate dimensions of nasopharyngeal space, flexion of cranial base, dimensions and morphology of Sella turcica. Analysis was done on the IC measure software for calculation of percentage coverage of nasopharynx, determination of cranial base angle and dimensional changes in Sella turcica.

RESULT:- Decrease in dimensions of Sella turcica, cranial base angle and dimensions of nasopharynx with increase in adenoidal dimension and percentage coverage of nasopharynx by adenoidal tissue was seen in Group II (experimental) when compared with Group I (control).

Pyramidal shape dorsum sellae was most commonly seen in Group II (experimental) while Normal shape Sella turcica was most common in Group I (control)

CONCLUSION:- Nasopharyngeal obstruction causes decrease in cranial base angle and dimensions (diameter, radius, circumference and area) of Sella turcica. There is also change in morphology of Sella turcica with nasopharyngeal obstruction.

INTRODUCTION

Moss[1] stated that forms are secondary and obligatory response to changes in function. He stated that form of skeletal tissue is determined by function of underlying capsular and periosteal matrix. Nasopharyngeal area is an important part of oro-facial capsule, and soft tissue of this region may have an important bearing on growth of adjoining skeletal structures. It was believed and expressed, that obstruction due to adenoids might influence the developing facial conformity. There are frequent references in the literature to the so called "adenoid type face". Adenoid, also known as the **nasopharyngeal** tonsil**,** is a pyramidal shape mass of lymphoid tissue found in the postero-superior wall of nasopharynx. The **top** of this pyramid is extended toward to nasal septum, and the base sits at the posterior most wall of the nasopharynx. Adenoid tissue grows principally downward and forward, rapidly during the early years of life (approximately 3 years of age) and then at a somewhat decelerated rate until its greatest bulk is achieved. According to **Subtelny (1955)**[2], the peak mass was observed to occur from the age of 10 to the age of approximately 14 to 15 years. After the peak of adenoid growth is achieved, the growth process seems to reverse itself and the adenoid tissue progressively decreases in mass. By adulthood the adenoids have usually atrophied completely. Normally, the nasopharynx enlarges to accommodate the growing adenoids, thus maintaining a patent nasopharyngeal airway. Any imbalance in this may result in reduced patency and nasopharyngeal obstruction which might influence the form of adjoining skeletal structures which is compensated by the variations in natural head position, ranging between extension and flexion due to altered respiratory pathway.[3] Experimental studies have shown that cervical extension increases maximum oropharyngeal airway size. Therefore, children with nasal obstruction will spontaneously tend to assume the extended or forward head posture.

Extension of the head for the shift from nasal to mouth breathing results in anterior and ascending displacement of the occipital condyles on the superior articular surfaces of the first vertebrae, Atlas. This causes the horizontal line of sight of the orbits to be angled upward, with resultant shift of the visual field, needed for postural compensation. One way to accomplish this, which is commonly observed in mouth breathers, is to increase the thoracic kyphosis. Another way possible with young children when the synchondroses of the cranial base are still patent is to increase the amount of flexion in the cranial base. An increase in cranial base flexion in primates has been shown to result

in decrease of the anterior-posterior length of the nasopharynx and shortening of the antero-posterior width of the mandibular ramus. Hence extension of the head in relation to the cervical vertebral column was correlated with a larger cranial base angle which can be further correlated with the one of the important landmark in Orthodontics, Sella turcica.[4] Thus, it was decided to evaluate dimensional changes of Sella turcica using linear measurement and flexion of cranial base in the present study.

Sella turcica, Latin word for Turkish seat, is a saddle shaped depression in the body of sphenoid bone behind the chiasmatic groove and the tuberculum sellae. The formation of the saddle is completed posteriorly by dorsum sellae, which is continuous with the clivus. It belongs to the middle cranial fossa and midpoint of Sella turcica serves as an important cephalometric landmark during Orthodontic diagnosis and treatment planning. This cephalometric landmark helps in knowing the relative position of maxilla and mandible to the cranium and to themselves. The Sella turcica is usually demarcated by a dense thin white line in lateral cephalograms. The Sella turcica houses the chef d'orchestre of the endocrine system, pituitary gland within the most inferior part, the hypophyseal fossa. The adult pituitary is composed of three lobes, the anterior and intermediate lobes that have a common developmental origin from the ectoderm, and the posterior lobe that is an extension of the ventral diencephalon or hypothalamus. The intermediate pituitary is a comparable homogeneous tissue channeling only melanotroph cells that induce α-melanotrophin (αMSH), the anterior lobe contains five different hormonesecreting lineages, including the corticotrophs that produce adrenocorticotrophin (ACTH), the gonadotrophs that makes the gonadotrophins luteinizing hormone (LH) and follicle-stimulating hormone (FSH), the somatotrophs that produce growth hormone (GH), the lactotrophs that produce prolactin (PRL) and, finally, the thyrotrophs that produce thyroid-stimulating hormone (TSH). The neural or posterior lobe of the pituitary is largely constituted of axonal projections from the hypothalamus that secrete arginine vasopressin and oxytocin (OT). The development of pituitary gland and sella turcica occurs through a complex process. The sella turcica area marks the migration of the neural crest cells to the frontonasal and maxillary developmental fields during embryological development. The anterior part of the pituitary gland, sella turcica and teeth share in common information and development, the involvement of neural crest cells, and dental epithelial progenitor cells evolve

through sequential and reciprocative interaction with neural crest derived mesenchyme. The posterior part develops from the para-axial mesoderm, closely related to notochordal induction.

Imaging of the sella turcica and of the pituitary anticipates modifications in and around the sella turcica that mirrors intracranial conditions, not solely those of the pituitary itself. The sella turcica is best anticipated on lateral views of the skull. Studies of the sella turcica size on radiographs have been based either on linear measurement, area measurement, volume measurement or perimeter of the sella turcica in different classes of malocclusion. According to **Taveras and Wood (1964)[5]**, 17mm was the maximal anteroposterior diameter of the Sella, depth measured perpendicular to the Sella floor from a line drawn amidst dorsum and tuberculum was 13 mm in most cases. Another studies quoted normal length as 10 and 15 mm. Amplification of the Sella turcica was thought to be an indicator of pituitary pathology, as were malformation of shape and contour of the Sella. Researchers have also seeked to use the area and the volume of the Sella turcica to serve as better predictors of pituitary disease. The volume is the product of one-half length x width x height. An area greater than 130 mm^2 and a volume greater than 1092 mm^3, have been reported to be abnormal. The morphology of the Sella was described subjectively and qualitatively, and alterations were categorized into different types such as circular, oval, flat, shallow and J-shaped. **Becktor et al. (2000)[6]** and **Jones et al. (2005)[7]** analysed the frequency of a Sella turcica bridge in patients with severe craniofacial deviations. They found a higher prevalence of a Sella turcica bridge of 18.6 and 16.7 per cent, respectively. **Marcotty, Reuther, Eisenhauer (2009)[8]** analysed skeletal Class III patients presented a significantly higher rate of Sella turcica bridging with 16.8 per cent in comparison with skeletal Class I patients with 9.4 per cent in patients who required combined surgical–orthodontic treatment. **Alkofide E.A. (2007)[9]** determined significant differences were found between the older (15 years or more) and the younger (11 – 14 years) age groups for length, depth, and diameter. **Yasser et al. (2010)[10]** concluded that males had slightly higher Sella turcica measurements than females with a non-significant difference between genders while class III sample had higher Sella turcica measurements with a non-significant difference among the skeletal classes.

However, literature is not available to establish relation between dimension of Sella turcica and nasopharyngeal obstruction. Recently two major physiologic factor- posture and respiration have

been implicated as possible modifying influences in the control of growth and the establishment of dentofacial morphology. Hence any alteration in respiratory pathway due to enlarged adenoids affects the postural head position ranging from extension to flexion, or results in large cranial base angle as seen in a study done by **Woodside and Linder-Aronson**[11] or may alter the growth of posterior cranial base. Since the flexural angle is measured from midpoint of Sella turcica, any change in cranial base angle may reflect as dimensional change in Sella turcica. Also, Sella turcica lies in the middle cranial fossa on the intracranial surface of the body of the sphenoid bone, any change in extension and flexion of head may also cause change in cranial base angle subsequently on dimensions of Sella turcica. The role of enlarged adenoids in altered dentofacial morphology is well established but till date no studies have been conducted to correlate dimensional changes in Sella turcica due to enlargement of adenoids. Therefore, it was decided to evaluate the dimensional and morphological changes of Sella turcica and alteration in cranial base angle secondary to nasopharyngeal obstruction due to enlarged adenoids.

AIM AND OBJECTIVE

Nasopharyngeal area is an important part of oro-facial capsule, and soft tissue of this region may have an important bearing on growth of adjoining skeletal structures. It was believed and expressed, that obstruction due to adenoids might influence the developing facial conformity. Normally, the nasopharynx enlarges to accommodate the growing adenoids, thus maintaining a patent nasopharyngeal airway. Any imbalance in this may result in reduced patency and nasopharyngeal obstruction which might influence the form of adjoining skeletal structures. At times this is compensated by the variations in natural head position, ranging between extension and flexion due to altered respiratory pathway.[3]

Extension of the head for the shift from nasal to mouth breathing results in anterior and ascending displacement of the occipital condyles on the superior articular surfaces of the first vertebrae, Atlas. This causes the horizontal line of sight of the orbits to be angled upward, with resultant shift of the visual field, needed for postural compensation. Hence extension of the head in relation to the cervical vertebral column was correlated with a larger cranial base angle which can be further correlated with the one of the important land-mark in Orthodontics, Sella turcica. The Alteration in size of the Sella turcica had been seen in pituitary pathologies. The morphology of the Sella was described subjectively and qualitatively, and alterations were categorized into different types such as circular, oval, flat, shallow and J-shaped. Becktor et al. (2000)[6] and Jones et al. (2005)[7] found increased frequency of a Sella turcica bridge in patients with severe craniofacial deviations. However, literature is not available to establish relation between dimension of Sella turcica and nasopharyngeal obstruction. The role of enlarged adenoids in altered dentofacial morphology is well established but till date no studies have been conducted to correlate dimensional changes in Sella turcica due to enlargement of adenoids. Therefore, it was decided to evaluate the dimensional and morphological changes of Sella turcica and alteration in cranial base angle secondary to nasopharyngeal obstruction due to enlarged adenoids.

This cephalometric study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow to evaluate the dimensional changes in Sella turcica and flexion of cranial base secondary to nasopharyngeal

obstruction due to enlarged adenoids and to find correlation between dimensional changes in Sella turcica with flexion angle of cranial base. Sample for the present study comprised of 100 lateral cephalograms of pre-treated patients with age ranging from 9 to 15 years which are equally distributed amongst the 2 groups with 50 sample in each group. The sample was selected and divided into 2 groups after assessment of percentage coverage of nasopharynx (adenoid length/nasopharyngeal space). For its assessment the exact center of Sella turcica (Sc) has to be determined. It is done by making the two circles touching maximum surface of interior of the posterior and anterior wall. The centres of these two circles are joined together and the centre of this line is considered as centre of the Sella turcica named as Sc. This method of measuring centre of a circular or elliptical body is also used by Khanna et al. (2011)[13] in their study. The advantage of this method is that it is efficient in calculating the dimensions of Sella turcica rather than arbitrarily marking the centre of Sella turcica. Considering Sella as an elliptical/oval body – diameter, circumference and area of Sella turcica is measured. A more reliable and new method to measure the dimension as well as to mark the centre of Sella turcica can be obtained through this study.

The group I represents the patients with normal adenoids with percentage coverage of nasopharynx of less than 45 while the Group II represents the patients with enlarged adenoids having percentage coverage of nasopharynx equal to or more than 45.

A total of ten parameters were considered in the present study with six parameters evaluating dimensions of Sella turcica (diameter from dorsum sellae, diameter from tuberculum sellae, average diameter, average radius, circumference, area), three parameters evaluating dimensions of nasopharyngeal space (nasopharyngeal space, adenoid dimension, percentage coverage of nasopharynx) and one parameter for evaluating cranial base angle (Graph 2, 3, 4). Also, morphology of Sella turcica was determined. Data obtained for both the groups was subjected to appropriate statistical analysis.

Following conclusion can be drawn from the present study conducted to evaluate dimensional changes in Sella turcica secondary to nasopharyngeal due to enlarged adenoids.

1. There was significant decrease in Sella dimension in subjects with nasopharyngeal obstruction due to enlarged adenoids (Group II) in comparison to subjects with normal sized adenoids (Group I).
2. Highly significant decrease in flexion of cranial base in subjects with enlarged adenoids (Group II) as compared to subjects with normal adenoids (Group I).
3. Significant decrease was seen in nasopharyngeal length in Group II when compared with Group I. Very highly significant increase was seen in adenoid dimension and percentage coverage of nasopharynx in Group II (experimental) when compared with Group I (control).
4. Amongst the morphological shapes of Sella turcica, normal shape of Sella turcica was most common in Group I and pyramidal shape dorsum sellae was most common in Group II.
5. Dimensions of Sella turcica shows positive correlation with cranial base angle. Diameter from dorsum sellae (DS) and diameter from tuberculum sellae (TS) shows significant difference with weak correlation. Average diameter of Sella turcica, average radius of Sella turcica, circumference of Sella turcica and area of Sella turcica shows highly significant difference with weak correlation.

The clinical application of the study suggests that alteration in size of Sella turcica might as well result in alteration of most important endocrine gland, Pituitary gland, housing in Sella turcica. Any alteration in Pituitary gland will further affect the hormonal secretions by this gland. Hence, it can be hypothesised that any change or alteration in dimensions of the Sella turcica may affect the height or weight of the subject. There may be a possibility that patients with enlarged adenoids if left untreated may have short stature or ectomorph body type.

Future research on the hormonal changes secondary to dimensional change in Sella turcica and its effect on physical attribute and body type due to any syndromes or pathologies are yet to be done.

REVIEW OF LITERATURE

Latham R.A et al, (1972)[12] studied the extent of movement of Sella after birth into childhood & adolescence.He has taken series of twelve specimens obtained at autopsy and ranging in age from full term to 18 years. It was found that the basi-occipital bone increased steadily in length but that the distance between sella and the spheno-occipital synchondrosis stayed relatively constant after the age of 6 months. The dorsum sellae remained cartilaginous for at least the first 5 years after birth, and during the first 10 years there was constant evidence of bone resorption on the posterior wall of the pituitary fossa and continuing growth at the spheno-occipital synchondrosis. It was concluded that the point sella continues to move in an upward and backward direction for about 10 years after birth because of a corresponding upward and backward remodeling of the pituitary fossa.

Melsen B (1974)[13] investigated to use histologic techniques to examine the midsagittal structures of the cranial base in normal human material from birth to 20 years of age, to describe the normal growth patterns in different areas according to age and sex and to increase the understanding of normal cranial base development, with particular reference to variations in size and shape. Investigations verify the stability of some of the structures. It is apparent that growth activity is individual variation, both in the development in length of the anterior cranial fossa and in surface remodeling. The increase in size of the sella turcica which occurs during growth is due to remodeling of the inner contour and is brought about by resorption of the lower half of the posterior wall and, to a varying extent, of the floor, because of remodeling in the sella turcica region, the reference point sella, defined as the center of the sella turcica, cannot be regarded as stable until long after puberty. Study yields new information on the growth patterns of structures of the cranial base, which may lead to a better understanding of the fundamental problems of development of the cranial base as to size and shape.

Linder-Aronson S (1979)[11] conducted a study on 81 mouth-breathing patients with hypertrophic adenoid where adenoidectomy was performed and was compared with a similar number of control cases with the same sex and ages but without any nasal obstruction problems following a 5-year follow-up study. The results have shown that children who had difficulties in nasal breathing were

characterized by increase in both the lower and total facial heights, less sagittal depth of the bony nasopharynx, lower position tongue, narrow upper arch, retroclined upper and lower incisors, the palatal vault with normal height, cross-bite or tendency towards cross-bite, a tendency towards open bite and normal antero-posterior relationship between upper and lower jaws. He concluded that after adenoidectomy there was a normalization of the inclination of the upper and lower incisors, of the upper arch width, of the sagittal depth of the bony nasopharynx and of the inclination of the mandibular plane to the maxilla.

Fujioka M, Young LW, Girdany BR (1979)[14] conducted a study to determine the validity of the ratio as an indicator of adenoidal size by evaluation of measurements of radiographs of 1,398 infants and children and comparison with a subjective visual assessment made by experienced observers in 92 patients. Absolute size of the adenoids and the size of and shape of the nasopharyngeal space are major factors that determine nasopharyngeal obstruction. Therefore, the measurement of adenoid and nasopharyngeal space was done radiographically as radiographic examination of nasopharynx is considered to be a simple method to determine the size, shape and position of the adenoids. The ratio of these two sizes can provide a simple arithmetic measure of nasopharyngeal obstruction. Results showed the mean AN ratio increased from 0.33 at age 1.5 months to 0.55 at age 1 year 3 months, and reached its highest value, 0.59, at age 4 years 6 months. The AN ratio gradually decreased from this peak value to 0.52 at age 12 years 6 months and then diminished sharply to 0.38 at age 1 5 years 6 months. They concluded that An AN ratio greater than 0.80 was present in 34 of 36 patients (94%) subjectively judged to have enlarged adenoids.

Vig PS, Showfety KJ, Phillips C (1980)[4] described dealing with the influence of total nasal obstruction, visual feedback deprivation, and a combination of both, on the posture of the cranium measured relative to a gravity-defined true vertical reference plane. They concluded that total nasal obstruction results in a progressive extension of the head. Removal of the nasal obstruction allows the pre-existing respiratory pattern to be resumed, results in a return of head posture to base line values. Simultaneous nasal obstruction and deprivation of visual feedback result in a response which is similar to that induced by nasal obstruction alone. Also, respiratory requirements dominate sight as a determinant of the neuromuscular control which regulates cranial orientation.

Weber ZJ, Preston CB, Wright PG (1981)[15] conducted a study to determine whether artificially induced extended head posture decreases the resistance to nasal airlflow. The experimental sample comprised 15 male students with normal vertical, facial proportions and no histories chronic mouth breathing. In the sample, head posture was assessed by measuring the craniovertical angle by means of an angle finder. Nasal resistance units were calculated from the parameters of nasal airflow and differential pressure across the nasal airway during the complete respiratory, cycle using an equation analogous to Ohm's law. Readings were obtained and were compared in both the normal and 10-degree extended head posture position. No association could be found between an extended head posture position and a decreased resistance to nasal airflow.

Anderson D, Popovich F (1983)[16] conducted study in annual sample, 10% of the boys and girls with the largest, most open cranial bases were compared with 10% boys and girls with smallest, most closed cranial bases at age 4,6,8,12, 16 years with respect to cranial length width and height, cranial base length and mandibular condyle position and angle class of occlusion. The children with flattest cranial bases had significantly larger upper cranial height, but much smaller cranial height, and as a result had smaller total cranial height than the children with the most closed cranial base angle. These children showed a strong tendency to class II malocclusion. None of the children had class III malocclusion and most of them had class I malocclusion. The results contradict the findings of Weidenreich, Enlow and Lavelle. However, it supports the findings of Bjork.

Chilton LA, Dorst JP, Garn SM, (1983)[17] conducted a study for measurement of the sella turcica in the variety of pituitary and other conditions. The volume, a more reliable measurement than sellar area, has been difficult to interpret for lack of adequate standards. This study presents mean and 10th, 50th, and 90th percentiles for sellar volume. In normal children aged 6-16 years on the basis of measurements in 960 sets of skull radiographs made for orthodontic purposes. Sellar volumes are plotted against chronologic age, and against skeletal age for the 62% of measurements for which a simultaneous bone age determination had been made. The sellar volume increases with age. Mean volume for a boy 5 years 9 months to 6 years 8 months is 228 mm3, for a boy 15 years 9 months to 16 years 8 months is 640 mm3. For most age groups, sellar volume in males is greater than in females. Tenth and ninetieth percentiles for sellar volume are widely separated, giving a

wide range of normal. Nevertheless, they should be useful In assessing sellar volume in clinical situations.

Solow B, Nielsen SS, Greve E (1984)[18] conducted a study on 24 children of age 7-9 years in 3 sets of association. Correlations were calculated between 27 morphologic; 8 postural; 2 airway variable. It was concluded that obstructed nasopharyngeal airways were, on the average, seen in connection with a large cranio-cervical angle and with small mandibular dimensions, mandibular retrognathism, a large mandibular inclination, and retroclination of the upper incisors. The observed correlations were in agreement with the predicted pattern of associations between craniofacial morphology, cranio-cervical angulation, and airway resistance, thus suggesting the simultaneous presence of such associations in the sample of non-pathologic subjects with no history of airway obstruction.

Elwany S (1987)[19] conducted a study to measure and assess the AN ratio in children selected for adenoidectomy and its reproductibility between different observers and its predictive reliability in determining candidacy for adenoidectomy. Sample includes 100 children scheduled for adenoidectomy with 68 boys and 32 girls in the age range 3-7 years. Clinical assessment was made by three observers. A history of snoring, from parents, was recorded as absent (0) or present (I). The adenoidal measurement and nasopharyngeal space measurement was done. The AN ratio was obtained by dividing the measurement for A by the value for N. The result and conclusion states that for practical purposes, a value of AN ratio greater than 0.73 may be considered indicative of pathological enlargement of the adenoids.

Friedland B, Meazzini MC, (1996)[20] reported a case with the incidental finding of pathologic lesion on a lateral cephalogram of a 26 year old white man. A diagnosis of a prolactinoma was made. The patient was treated pharmacologically and to receive regular follow-up by the neuroendocrinologist and a neurosurgeon. It is a reminder of the important role that the dental profession can play in the detection of skull lesions. Orthodontists and oral surgeons especially take lateral cephalograms routinely as part of their treatment planning. They also review the normal plain film radiographic anatomy of sella turcica and briefly discuss the differential diagnosis of an enlarged sella.

Denk C, Onderoglu S, Ilgi S, Gurcan F, (1999)[21] conducted this study to measure the coronal and sagittal heights of the pituitary glands by magnetic resonance imaging (MRI) technique in 201 individuals. The data were evaluated according to age and sex groups. In all cases the coronal and sagittal heights of the pituitary glands were equal. The mean values of the coronal and sagittal heights in females were higher than that of males. The highest values for the coronal and sagittal heights were in the 11-20 years age group in both sexes. A gradual increase in the coronal and sagittal heights of the pituitary glands in the 0-10, 11-20 age groups was present in both sexes. Decrease in the heights of the pituitary glands was noted after 20 years of age onwards. Nevertheless, there was a conspicuous increase in the mean value of the pituitary glands' heights in the 51-60 years age group in males. In females, a minimal increase in the mean value of the pituitary glands' heights was observed in the 61 years and over age group.

Leiberman DE, Pearson OM, Mowbray KM (2000)[22] examined the extent to which the major dimensions of the cranial base (maximum length, maximum breadth, and flexion) interact with brain volume to influence major proportions of the neurocranium and face. A series of measurements were taken on each cranium from external landmarks and from radiographs. Exocranial linear dimensions to the nearest 0·1 mm were taken using Mitutuyo digital sliding or spreading calipers. Lateral and superior–inferior radiographs were taken of all specimens using an ACOMA_ portable X-ray machine on Kodak XTL-2 film. The data, therefore, clearly support the hypothesis that attained growth in the breadth, length and flexion of the cranial base result from independent processes in the sense that they do not appear to affect each other's size. These aspects of cranial vault thickness, common to all Pleistocene populations, have a different etiology, most probably a function of systemic cranial and/or skeletal bone growth. In addition, the above results tentatively indicate that occipital bunning in Neanderthals, who have wide cranial bases relative to endocranial volume, must be accounted for by other factors perhaps related to the timing of brain growth relative to basicranial growth, and thus may not be entirely homologous with the morphology occasionally evident in anatomically modern H. sapiens.

Becktor J, Einersen S, Kjaer I, (2000)[6] conducted a study on to visualize occurrence of Sella turcica bridge in a group of patients with craniofacial deviations treated by surgery. Profile radiographs of 177 individuals who had undergone combined orthodontic and surgical treatment. Two types of Sella turcica bridge was classified Type A: ribbon like fusion and Type B: extension of anterior and/or posterior clinoid process, with a thinner fusion. 33% individuals found to had sella turcica bridge with 10 individuals with Type A Sella bridge and 23 individuals having Type B Sella bridge. This study showed increased occurrence of a Sella turcica bridge in individuals with severe craniofacial deviatons.

Klocke A, Nanda RS, Nieke BK (2002)[23] conducted a longitudinal study to evaluate skeletal features in patients with small and large cranial base angles. Two groups were formed on the basis of small and large cranial angle group: the large cranial angle group consisted of subjects with N-S-Ar angle more than 125^{o} and small cranial angle group consisted of N-S-Ar angle less than 125^{o}. Analysis of data at the age of 5 years and 12 years for the both the groups reveal significant difference of the variables SNA, SNB, individualized ANB and Y axis. The unadjusted ANB angle, subjects with a large cranial base angle in the primary dentition demonstrated a skeletal class II tendency.

Dhopatkar A, Bhatia S, Rock P (2002)[24] conducted a retrospective cephalometric study to explore the role of the cranial base angle in the various groups of malocclusion. A total of 200 cephalometric radiographs of Caucasian patients (50 for each malocclusion group, with an age range between 8–12 years) were selected for the study. Each group contained approximately similar numbers of males and females, and the mean ages for each group were 10.4 years for the class I group; 10.10 years for class II, division 1; 11.1 years for class II, division 2; and 10.2 years for the class III group. The correlation between maxillary length and angle SNA was small but statistically significant, correlations between mandibular lengths and SNB angle were somewhat stronger. There was no apparent link between cranial base angle and skeletal base pattern as indicated by variable ANB. They concluded that the cranial base angle alone does not appear to play a pivotal part in the establishment of malocclusion and jaw lengths are significantly different between the malocclusion groups. The maxillary length is increased in class II malocclusions and the mandibular length is greater in class III.

Cederberg RA, Benson BW, Nunn M, English JD, (2003)[25] conducted a study with a purpose to evaluate the prevalence of calcifications of the sella turcica, in particular, calcification of the interclinoid (ICL) and petroclinoid ligaments (PCL). Lateral cephlometric radiographs of 255 subjects presenting for orthodontic evaluation were taken. The number of subjects selected for this study was determined by power analysis. Two calibrated raters reviewed cephalometric projections and scored the films using a standardized rating scale. The rating scale classified interclinoid ligaments (ICL) into one of four categories depending on the degree of calcification and PCLs as either, no calcification, partial or complete calcification. Results showed calcification of the ICL ranging from 39% rated as more than half calcified to 8% completely calcified. Petroclinoid analysis revealed 67% with no calcification, 23% with partial calcification and 9% completely calcified. Spearman's correlations were computed between age and the degree of calcification and between the degree of calcification for these two ligaments with a significant association between age and degree of calcification in the PCL, and a significant association between the degree of calcification in the petroclinoid and ICL. In addition, chi-squared tests demonstrated statistically significant associations between the presence of calcification in the PCL to the distribution of age and between the presence of calcification in the ICL to the distribution of age. They concluded that as calcification of these ligaments has suggestive associations with disease entities, their recognition as a variant of normal anatomy should be evaluated when assessing cephalometric radiographs.

Axelsson S, Storhaug K, Kjaer I (2004)[26] conducted a study was to establish normatice longitudinal cephalometric standards of size and to describe the morphology of Sella turcica in 72 Norwegian children between 6 and 21 years of age. The length, depth and diameter of the Sella turcica was measured and the mean values were analysed longitudinally. The length of the Sella was almost constant throughout the observation period and depth and diameter increased with age. No differences between males and females were detected for the depth and diameter of the Sella turcica, but the length was larger in males throughout the observation period. were measured and compared with normal reference material from university of Oslo. The two-dimensional size of Sella turcica was smaller in the WS group as compared with the control group. The morphology

of sella was assessed and five different types were identified. The female subjects had slightly more Sella turcicas with aberrant morphology.

Axelsson S, Storhaug K, Kjaer I (2004)[27] conducted a study to investigate the size and morphology of the sella turcica on cephalogram of individuals with Williams syndrome. Length, depth and diameter in 62 Norwegian children were measured and compared with normal reference material from university of Oslo. The two-dimensional size of Sella turcica was smaller in the WS group as compared with the control group. The morphology of sella was assessed and five different types were identified. The occurrence of irregularity (notching) of dorsum Sellae was more in WS subject. Females with WS had more dysmorphic Sella as compared to males with WS.

Balasubramanian S, Orungaty A, Gupta R (2004)[28] conducted a study on a sample of 48 Indian children with enlarged adenoids and of similar socio-economic status and racial background. In order to include early as well as late growers children between 9-14 years were selected. To establish norms for the Indian adolescent population, a control group on basis of 1:1 ratio with the sample size was established. Airway size was considered to be the limiting factor to decide whether there should be a shift to mouth breathing and consequently malocclusion. The airway measured at four regions. Significant results included a downward rotation of the mandible. It was found that there was no direct correlation between most facial proportions and airway patency.

Lessa F. C. R et al, (2005)[29] evaluated the differences in facial proportions of nose & mouth breathing children using cephalometric analysis. Sixty cephalometric radiographs from pediatric patients aged 6 to 10 years were used. After otorhinolaryngological evaluation, patients were divided into two groups: Group I, with mouth breathing children and group II, with nose breathers. Standard lateral cephalometric radiographs were obtained to evaluate facial proportions using the following measures: SN.GoGn, ArGo.GoMe, N-Me, N-ANS, ANS-Me and S-Go; and the following indexes: PFH-AFH ratio: S-Go/N-Me; LFH-AFH ratio: ANS-Me/N-Me and UFH-LFH ratio: N-ANS/ANS-Me. They observed that the measurements for the inclination of the mandibular plane (SN.GoGn) in mouth breathing children were statistically higher than those in nasal breathing children. The posterior facial height was statistically smaller than the anterior one in mouth

breathing children (PFH-AFH ratio). Thus, the upper anterior facial height was statistically smaller than the lower facial height (UFH-LFH ratio). They concluded that mouth breathing children tend to have higher mandibular inclination and more vertical growth. These findings support the influence of the breathing mode in craniofacial development.

Nie X (2005)[30] conducted a study to review the aspects of cranial base in detail, with a focus on developmental features, roles in craniofacial growth, anomalies, and the genetic basis of development. The cranial base is of crucial importance in integrated craniofacial development. As distinct from facial bones, it is formed through endochondral ossification. The posterior and anterior cranial bases are derived from distinct embryologic origins and grow independently—the anterior cranial base solely from the neural crest, the posterior cranial base from the paraxial mesoderm. The anterior cranial base has more prolonged and active growth and exerts more influence on facial growth than does the posterior cranial base. Cranial base angulation is a unique feature in modern human beings. Cranial base anomalies have been identified in many genetic and developmental disorders. The molecular basis of cranial base development and growth is being clarified.

De Marinis L, Bonadonna S, Bianchi A, Maira G, Giustina A, (2005)[31] conducted study to report the clinical experience of two Italian endocrine centers, which are referral centers for pituitary diseases of large areas in Northern (Brescia) and Central (Rome) Italy. Sample was comprised of 171 female and 42 male patients affected by PES (primary empty Sella. The mean age at diagnosis in their subjects was 51.8 ± 2.1 yr. Mean body mass index was 27.3 ± 3.5 kg/m2. Results showed that in the overall population, out of 213 patients, 31 females and 9 males had documented endocrine abnormalities. 22 patients with 18 women and 4 males, presented with hyperprolactinemia. Global anterior hypo pituitarism was confirmed in 9 patients. 8 patients presented an isolated GH deficiency. 130-84 patients presented a so called partial empty Sella at computed tomography scan/magnetic resonance imaging, and 75 had total PES. They concluded that PES may be associated with variable clinical conditions ranging from mild endocrine disturbances to severe intracranial hypertension and rhinorrhea. The need for treatment of hyperprolactinemia as well as for replacement hormone therapy must be assessed in PES. Symptomatic intracranial hypertension makes cerebrospinal fluid shunting procedures necessary.

Jones RM, Faqir A, Millett DT, Moos KF, McHugh S, (2005)[7] conducted a study with aim to compare the incidence of Sella turcica bridging and Sella turcica dimensions in 150 Caucasian subjects who had combined surgical-orthodontic correction of their malocclusion with a randomly selected group of 150 Caucasian subjects who were treated contemporaneously by orthodontic means only. Pretreatment lateral cephalometric radiographs were scanned and analyzed. The dimensions of the Sella turcica were measured. In the group treated by combined surgical-orthodontic means, the incidence of bridging was 16.7%, whereas it was 7.3% in the orthodontics only group. Significant increases in the mean surface area and mean perimeter of the sella turcica were found for the combined surgical-orthodontic group compared with the orthodontics only group. The mean inter-clinoid distance was significantly smaller in the surgical Orthodontic group. These findings appear to indicate the greater likelihood of sella turcica bridging and abnormal sella turcica dimensions in subjects treated by combined surgical-orthodontic means rather than by orthodontics only.

Alkofide EA (2007)[9] conducted a study to describe the shape and size of the sella turcica in Saudi subjects with skeletal Class I, Class II and Class III malocclusion. Sample for the study consisted of 180 lateral cephalogram of individuals (90 males and 90 females) with an age range of 11 – 26 years and were distributed with 60 subjects in each group. The results showed that the sella turcica presented with a normal morphology in the majority of subjects (67 per cent) and no significant differences in linear dimensions between genders could be found. Whereas when age was evaluated, significant differences were found between the older (15 years or more) and the younger (11 – 14 years) age groups for length, depth, and diameter. When skeletal type was compared with sella size, a significant difference was found in the diameter of sella between the Class II subjects which has smaller diameter and Class III subjects which has larger diameter.

Peltomäki T (2007)[32] explained the development of adenoid facies occurring by changes in head and tongue position and muscular balance. After adenoidectomy and change in head and tongue position, accelerated mandibular growth and closure of the mandibular plane angle have been reported. Children with obstructive sleep apnoea (OSA) have similar craniofacial characteristics as those with large adenoids and tonsils, and the first treatment of choice of OSA children is removal of adenoids and tonsils. These children also have abnormal nocturnal growth hormone (GH)

secretion and somatic growth impairment, which is normalized following adenotonsillectomy. Hence, it is hypothesized that decreased mandibular growth in adenoid face children is due to abnormal secretion of GH and its mediators. After normalization of hormonal status, ramus growth is enhanced by more intensive endochondral bone formation in the condylar cartilage and/or by appositional bone growth in the lower border of the mandible. This would, in part, explain the noted acceleration in the growth of the mandible and alteration in its growth direction, following the change in the mode of breathing after adenotonsillectomy.

Andredaki M, Koumantanou A, Dorotheou D & Halazonetis D.J, (2007)[33] measured quantitavily the size and shape of sella turcica sella turcica and thus establish normative reference standards that could assist in a more objective evaluation and detection of pathological conditions. Standardized lateral cephalograms of 184 healthy Greeks (91 males and 93 females) were used. The age range was between 6 and 17 years. Conventional measurements included three different heights of the sella turcica (anterior, posterior, median), its length, and width, measured in relation to the Frankfort reference line. In addition, the area of sella turcica was calculated. Morphometric methods were used to assess shape. The tracings were superimposed using the Procrustes method, and the average shape was computed. Principal component analysis (PCA) was used to assess shape variability. The data were correlated with centroid size, age, and gender. Unpaired *t* -tests were used to determine gender differences. Sella height anteriorly was the only variable found to be signifi cantly different between the genders, being larger in females by 0.5 mm. Linear and area measurements were found to be significantly correlated with age, but all correlations were low (*r* 2 below 8 per cent). Sella turcica shape, as described by PCA, was different between males and females, mainly at the posterior aspect of the sella outline. However, although there was an extensive overlap between the genders, and differences were minimal. Age was not found to be correlated with the shape, although, in the female group, the first principal component of shape was marginally not significant. Allometry was observed in both genders, the sella showing a tendency towards a flatter and wider shape with increase in size.

Jacobsen M, Pallisgaard C and Kjær I, (2009)[34] compared the morphology of sella turcica of individuals within pairs of monozygotic twins with normal karyotype and to analyze the similarity between the observed morphology and the morphology of non-twins at the same age with normal

karyotype. Material comprised of the profile radiographs of 84 individuals of 42 twin pairs (18 male and 24 female pairs) with age ranging between 18–23 years. Sella turcica measurements from non-twins aged 6–21 years were used as normal reference. Length, depth and diameter of the sella turcica were measured. Pearson's correlation coefficient was used for comparison of individuals within twin pairs. The study showed that the size of the Sella turcica may be partly similar and partly dissimilar within the pair of monozygotic twins. Statistical evaluation of the data showed correlations between length, depth and diameter of the Sella turcica between the two twin individuals in the same twin pair. Differences in sizes are observed between individuals in the twin material and individuals in the non-twin material. As a conclusion, the twin males were more similar within the twin pair, but deviated more from the non-twin material than the females. Female twins had more discrepancy within the twin pair, but deviated less from the non-twin material than the males.

Yasser YA, Nahidh M, Yousif HA (2010)[10] conducted a study to evaluate the size of sella turcica and to determine its correlation with gender and different skeletal class in Iraqi subjects on lateral cephalogram. The sample included 130 pretreatment digital lateral cephalometric radiographs (67 female and 63 males) with an age range between 17-25 years and was divided according to ANB angle into 3 skeletal classes. Results have shown that males had slightly higher sella turcica measurements than females with a non-significant difference. While class III sample had higher sella turcica measurements with a non-significant difference among the skeletal classes. Also, six distinct variations of sella turcica were identified, with the highest percentage to the normal morpholgy.

Marcotty PM, Reuther T, Eisenhauer AS (2010)[8] conducted a study to analyze the prevalence of sella turcica bridging and measure the size of the sella turcica in two well-defined groups of Caucasian individuals with class I and Class III skeletal malocclusion. 400 pre-treatment lateral cephalograms of adult patients over 17 years of age with a skeletal Class III (132 females, 118 males) and a skeletal Class I (94 females, 56 males) malocclusion were analyzed. They concluded that skeletal Class III patients presented a significantly higher rate of sella turcica bridging in comparison with skeletal Class I patients. Whereas no differences between females and males were detected for the length, depth, and diameter of the sella turcica.

Khanna R, Tikku V, Sharma VP, (2011)[35] undertaken the study to compare the pharyngeal dimensions in Angle's Class I normal and Angle's Class II division 1 samples and to correlate it with the dentoskeletal parameters in both the groups. The sample consisted of 92 pretreatment lateral cephalogram, which were categorized into two groups, Group A and Group B, that they should present Angle's Class I and Angle's Class II molar relationship. Each group consists of 25 males and 21 females. Descriptive statistics for 14 variables were calculated. Results showed that the positional alteration of hyoid was prevalent in skeletal mal-relationship rather than dentoalveolar malocclusion. The anteroposterior dimension of pharynx at hyoid level was more in males than in females, and it was relatively less in Angle's Class II Division 1 samples to Class I samples. No significant sexual dimorphism exists in angular measurements of hyoid positioning. They concluded that Angle's Class II Division 1 samples with retrognathic mandible showed an inferoposterior displacement of hyoid bone.

Sathyanarayana HP, Kailasam V, Chitharanjan AB (2013)[36] conducted a study to measure the size and describe the morphology of sella turcica on lateral cephalometric radiographs of 180 subjects (91 males and 89 females) in age group of 9-27 years and grouped them into Class I, Class II and Class III with 60 subjects in each group. Results have shown that considering the age groups, linear dimensions were larger in older group than in younger group, on the other hand, significant differences were noted in length between males and females. When skeletal types were compared in respect to sella size, significant difference was found in length and diameter. The shape of sella turcica appeared in majority of cases.

Kamak H, Çatalbaş B, Şenel B (2013)[37] conducted a study to examine the differences between cranial base measurements in different skeletal malocclusion patterns in patients with Turkish cephalometric norms. Data that will be useful in diagnosis and Orthodontic and jaw surgery treatment planning. On lateral cephalometric radiographs of 90 healthy orthodontic patients cranial base measurements were made. The sample was divided in three groups on basis of skeletal malocclusion with 30 samples in each group with different skeletal malocclusions (Class I: 30 subjects, Class II: 30 subjects, Class III: 30 subjects) with a normal vertical growth pattern. Cranial base flexure measurements, anterior and posterior cranial base inclinations, and linear measurements for the assessment of cranial base dimensions were analyzed. For statistical

evaluation, ANOVA test was performed. Least significant differences test was used to determine the individual differences. Results showed both anterior (SN) and posterior (SBa) cranial base lengths, N-S-Ba cranial base flexure angle and posterior cranial base inclination angle (SBa-FH) did not show statistically significant differences between the three groups studied. Anterior cranial base inclination (SN-FH) was increased significantly in the Class II group compared to Class I and Class III groups. N-S-Ar cranial base flexure angle was also increased significantly in the Class II group compared to Class III. They concluded that Cranial base morphology differences among skeletal malocclusions were observed for the N-S-Ar and SN-FH angles in Class II group.

Chauhan P, Kalra S, Mongia S, Ali S, Anurag A, (2014)[38] conducted a study to describe the morphology and to measure the dimensions of the Sella turcica in North Indian population. A sample of 180 lateral cephalometric radiographs of individuals (90 males and 90 females) with an age range of 12 - 65 years were taken. Morphology of Sella turcica was studied and various measurements were taken to determine the shape of the Sella. The study found that Sella turcica presented with a normal morphology in only 28 per cent of the subjects. A significant difference in linear dimensions between genders was found in Sella height and width. When age was evaluated, some dimensions showed negative correlation with the age. Sella size of the older age group was larger than the younger age. They concluded that pathological enlargement of the pituitary fossa can be detected by this technique and may also be helpful in providing data in the assessment of racial, gender, age specific variation in the skull.

Kjaer I (2015)[39] reviewed summary of two decades of published and unpublished studies on normal and pathological development of Sella turcica and pituitary gland in humans. The studies include histological analyses of human prenatal material and profile radiographic analyses of human postnatal material, supplemented in a few cases with neuroradiology. Prenatal and postnatal results were compared and similarities between prenatal and postnatal deviations in Sella turcica morphology were demonstrated. Variations in morphology of the pituitary gland were observed in several cases. For diagnostic purposes, the review distinguishes between deviations in the anterior wall and in the posterior wall of the Sella turcica. Variations in the anterior wall seem to be associated with malformations specifically in the frontonasal developmental field, while variations

in the posterior wall are often connected with malformations in the posterior structures, e.g. the cerebellum. In normal cases, minor deviation in morphology are observed. In each pathological case, a specific malformation pattern was observed in Sella turcica morphology, varying from mild to severe phenotype. The malformation in the Sella turcica/ can cause changes in pituitary gland which can be associated with a malformation within a developmental field that forms the craniofacial region (frontonasal, maxillary, palatal, and mandibular fields), sometimes also involving the brain stem, thymus, thyroid, and heart (velo-cardiofacial syndrome). Pathological Sella turcica morphology can also be associated with malformations in the cerebellum and larynx (Cri-du-Chat syndrome). This review demonstrates the value of combining profile radiographic diagnostics with neuroradiological diagnostics in cases with malformed Sella turcica.

Konwar S, Singhla A, Bayan R (2016)[40] conducted a study was to analyze the morphological dimensions of sella turcica and to determine if differences exist due to gender, age or in subjects with different skeletal patterns. A total of 100 (43 males and 57 females) sella turcica on cephalometric radiograph was traced. Linear dimensions of sella turcica (length, depth, and diameter [in mm]) were measured and morphology (normal, bridging, double contour, oblique, irregular, and pyramidal) was assessed. A Student's t-test was used to calculate the mean differences between the genders, different age groups and skeletal types. A Chi-square test was used to test the interrelationship of gender, age and skeletal types with the shape of sella turcica. Results showed that in low angle group subjects, 80% of the subjects had normal sella and 20% of the subjects had variations in morphology and in high angle group subjects, 76% of the subjects had a normal sella, and 24% of the subjects had variations in the morphology. There was a significant difference in length between high and low angle subjects, where the length of sella was larger in the low angle subjects and the distribution of shape of sella turcica was found to be significantly different among both high and low angle types and assessment of the sella turcica should be carried out during cephalometric analysis in orthodontic treatment.

Pigolkin Y, Corro V (2016)[41] conducted a study to evaluate age related changes of the Sella turcica morphometry in adults older than 20-25 years. Dimensional examination of the Sella turcica was carried out on cadavers with the cranium opened by a circular vibrating saw. The sample consisted of a total of 90 Russian subjects, ranging in age from two months and 87 years. Results

showed the tendency of dimensional variations throughout life. There were no observed gender differences in the morphometry of the Sella turcica. The dimensions of Sella turcica in respect to depth and length values revealed the possibility to categorize an examined sample in a certain age period. They concluded on basis of the results of existing methods of age determination, the morphometry of the Sella turcica can be an additional characteristic, amplifying the received values, and accordingly, increasing the accuracy of forensic biological age diagnosis.

Ghaida J.H., Mistareehi A.J., Mustafa A.G., Mistarihi S.M.A, Ghozlan H.H. (2017)[42] conducted a study with main objective to build up a normative database of the dimensions of the Sella turcica in the Jordanian population. Their sample consisted of 509 computed cephalograms of 252 male and 257 female healthy Jordanians with age range of 10–40 years were collected and divided into two groups, adolescent and adult age, for both genders. Viewbox 3 software was used to determine linear dimensions and area of the sella turcica. Their results showed that the overall values for width, length, height, area, and aperture (interclinoid distance) were 8.72, 7.68, 6.25, 40.80, 3.92, and 8.67, 7.42, 6.38, 41.26, 3.68 mm (mm2) for males and females, respectively. Significant differences were found between adult male group on one hand and adolescent female group and adult female group on the other hand. Between age categories and within male and female groups, sella parameters were significantly different between adolescent and adult age-groups. They concluded that there are clearly increase in parameters with age, irrespective of gender, with the area scoring the highest increase, and the height in females and length in males contributing most obviously to this trend. The aperture appears to decrease in females while it increases in males as adulthood is reached. This seems to reflect differential growth of the pituitary gland under neurohormonal effects.

Yaşa Y, Büyük SK, Benkli YA, Arslan A, Topbaşı NM (2017)[43] conducted a study to assess the shapes and measurements of sella turcica in adolescent orthodontic patients with different growth patterns. Sample consisted of 96 (32 low angle, 32 average angle, 32 high angle). They found a significant difference in diameter and depth of sella turcica among different growth patterns. Larger diameter and depth values were present in low and high angle individuals. Moreover, the results showed that sella turcica presented with a normal morphology in the majority of subjects.

Kadam P, Sabharwal A, Patil A, Sabane A, Bhosale V (2019)[44] conducted a study to investigate the normalcy of the dimensions of Sella turcica and to compare the relationship of Sella turcica with different malocclusions. A total of 90 pre-treatment digital lateral cephalograms were selected according to criteria and grouped into 3 groups. Group I was Class I(n=30), Group II was Class II (n=30) and Group III was Class III (n=30). Lateral cephalograms were traced and studied on the basis of Sella turcica. The linear measurements recorded were length, depth and diameter of the Sella turcica. ANOVA and a post hoc test (Bonferroni and Sidak) were used for multiple comparisons. $P<0.05$ was considered as level for statistically significant data. Results showed the linear measurements of length and diameter showed statistically significant differences in Class I, Class II, Class III. However, depth showed no statistically significant difference in the group. They concluded that in Skeletal Class III or prognathic mandible, the antero-posterior dimensions of the Sella turcica, i.e., the length and the diameter are the largest as compared to Class I and Class II. Depth of Sella turcica and the effective length of the mandible do not correlate with the three skeletal types.

MATERIAL AND METHOD

This cephalometric study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow to evaluate the dimensional and morphological changes in sella turcica and flexion of cranial base secondary to nasopharyngeal obstruction due to enlarged adenoids and to find correlation between dimensional changes in sella turcica with flexion angle of cranial base.

MATERIALS

A. Sample

The data were collected from the record files of the patients with enlarged adenoids and with normal sized adenoids either treated or undergoing Orthodontic treatment in the Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow. Initially total of 60 lateral cephalograms were selected of patients with normal sized adenoids and 75 lateral cephalograms were selected of patients with enlarged adenoids. Final sample size was ascertained after cephalometric analysis and comprised of 100 pre – treated lateral cephalograms with age ranging from 9 to 15 years, equally subdivided in two groups – Group I (Control) and Group II (Experimental).

Criteria for sample selection

Inclusion criteria

1. Age of patients between 9-15 years.
2. Patients with clearly visible adenoids in pre-treatment lateral cephalograms.
3. No history of previous Orthopaedic or Orthodontic treatment.
4. No relevant medical and dental history.

Exclusion criteria

1. Patients with congenital defects.
2. Patients with history of trauma or surgery in craniofacial region.
3. History of tonsillectomy or adenoidectomy.

4. Patients with associated syndromes.
5. Patients with facial asymmetry.

ETHICAL COMMITTEE APPROVAL

Approval was taken from the Ethical and Research Committee of Babu Banarasi Das College of Dental Sciences, BBDU, Lucknow. A signed informed consent was obtained from each patient undergoing the treatment as per guidelines of the University.

B. Material used for obtaining lateral cephalogram

a) **Cephalostat machine:** Planmeca proline XC cephalostat (Finland) machine. The exposure was set at 68 KV, 5 mA and exposure time of 2.3 second and receptor was placed at a distance of 6.0 inches. The basic equipment required to obtain lateral cephalometric views consists of an X ray source, an adjustable cephalostat, a film cassette with radiographic intensifying screens and a film cassette holder. All of these components are rigidly attached to each other at a fixed distance, to form cephalometric radiographic unit (Fig. 1A).

C. Material used for tracing and measuring the landmarks on lateral cephalogram

a) **Soft copy of lateral cephalograms:** All lateral cephalograms were transferred to a computer loaded with planmeca software from where the digital lateral cephalogram were saved in CD ROM in bitmap file format. Lateral cephalograms of each patient saved in CD-ROM were taken from record files of selected patients and saved as JPEG image in the computer.

b) **Microsoft paint:** Microsoft paint version 1703 was used to locate the selected landmarks (Fig. 2).

c) **IC Measure software**: IC Measure software 1.3 was used to measure the parameters (Fig. 3).

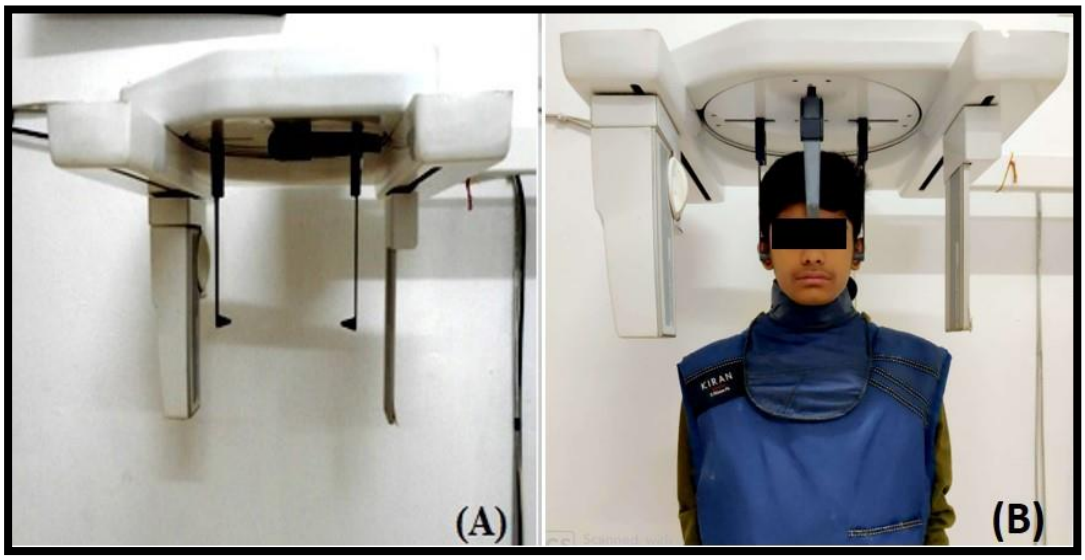


Figure 1: Materials used in the study (A) Cephalostat machine for taking lateralcephalogram (B) Patients position while taking lateral cephalogram in the cephalostat machine

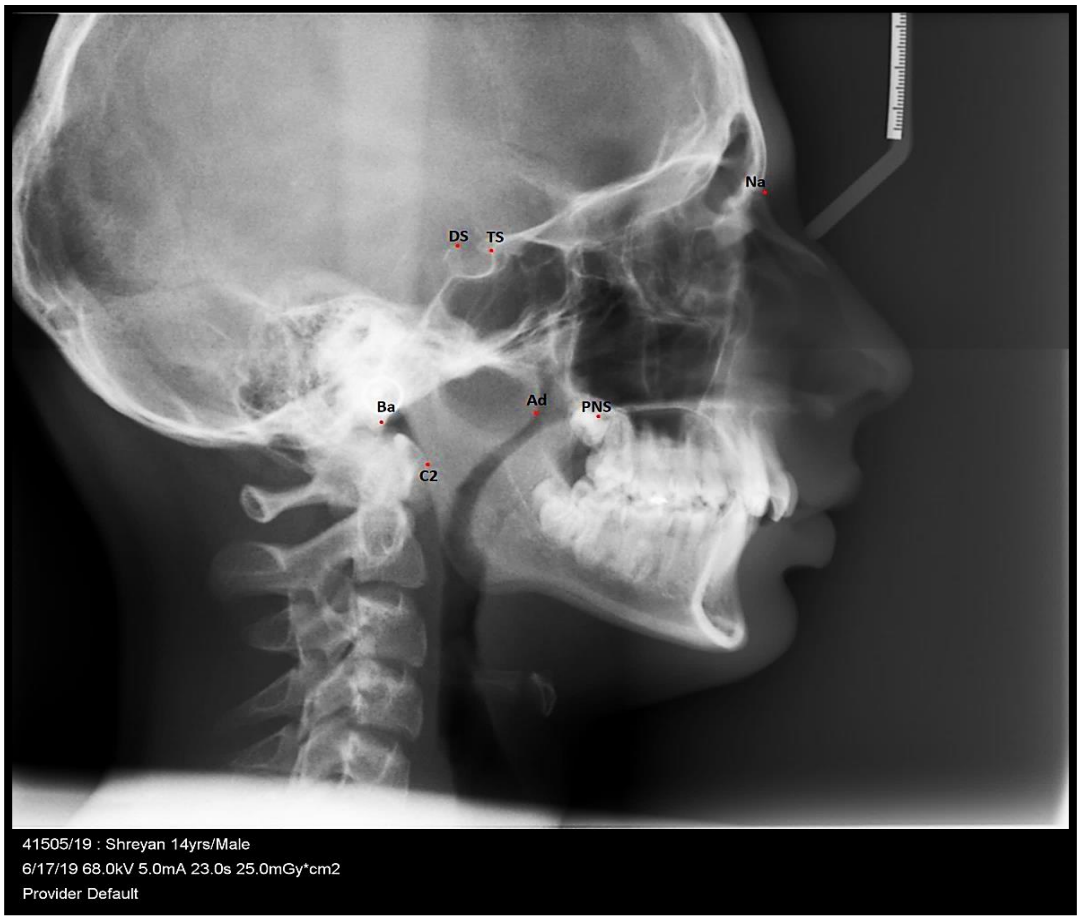


Figure 2: Cephalometric tracing using Microsoft paint

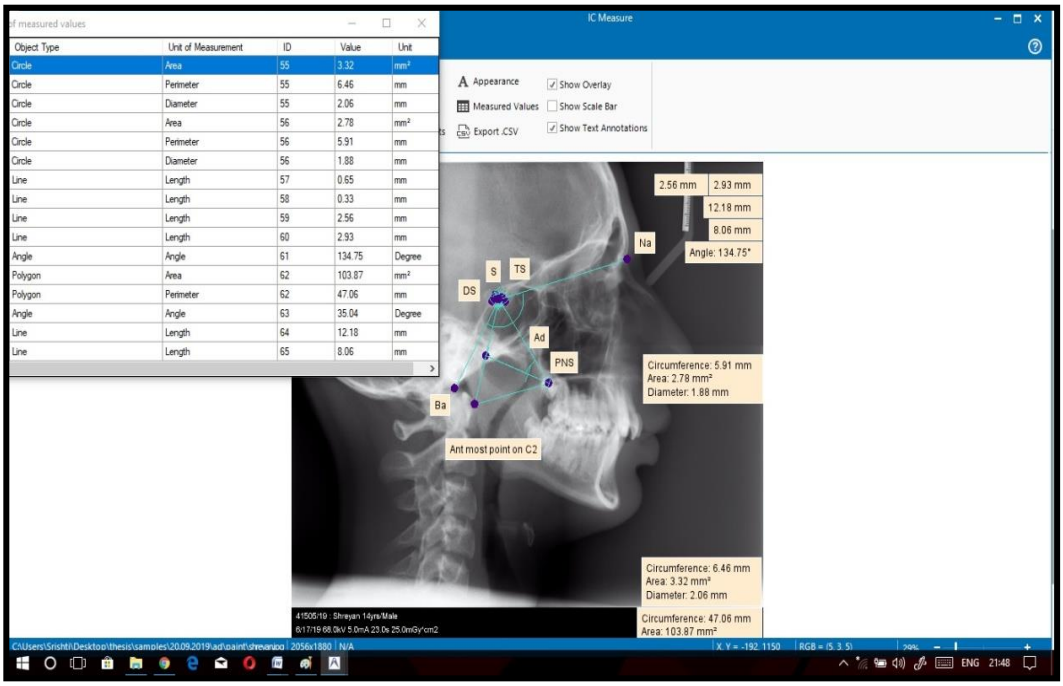


Figure 3: Cephalometric readings using IC Measure

METHODOLOGY

1. OBTAINING LATERAL CEPHALOGRAM

Planmecaproline XC cephalostat (Finland) was used to take the digital cephalograms of subjects following a standard protocol. Digital cephalograms were taken with functional head positioner and patients were made to stand in natural head position, i.e. a standardized and reproducible orientation of head in space. To achieve natural head position, each subject was asked to see on a distant point at eye level in the wall mirror. The ear post was used for correct sideways alignment of patient's head so that image would be symmetric and undistorted in right-left direction. The subjects were asked to occlude in maximum inter-cuspation i.e. centric occlusion and leave the lips relaxed. The receptor- source distance was fixed at 60 inches. The exposure values were set at 68 KV, 5mA, and exposure time of 2.3 seconds (Fig. 1B).

2. PROCEDURE FOR THE SAMPLE SELECTION

Sampling Method

Percentage coverage of nasopharynx (%) was evaluated for all the pre-treatment lateral cephalogram (60 for patients with normal sized adenoids and 75 for patients with enlarged adenoids) initially selected for study.

LANDMARKS, PLANES AND PARAMETERS USED FOR SAMPLING

A. For Evaluation of percentage coverage of Nasopharynx:

- **Landmarks identified on MS Paint:** (Fig. 4)

1. **C2:** Anterior most point on the second cervical vertebrae.

2. **PNS:** Most posterior aspect of the palatine bone.

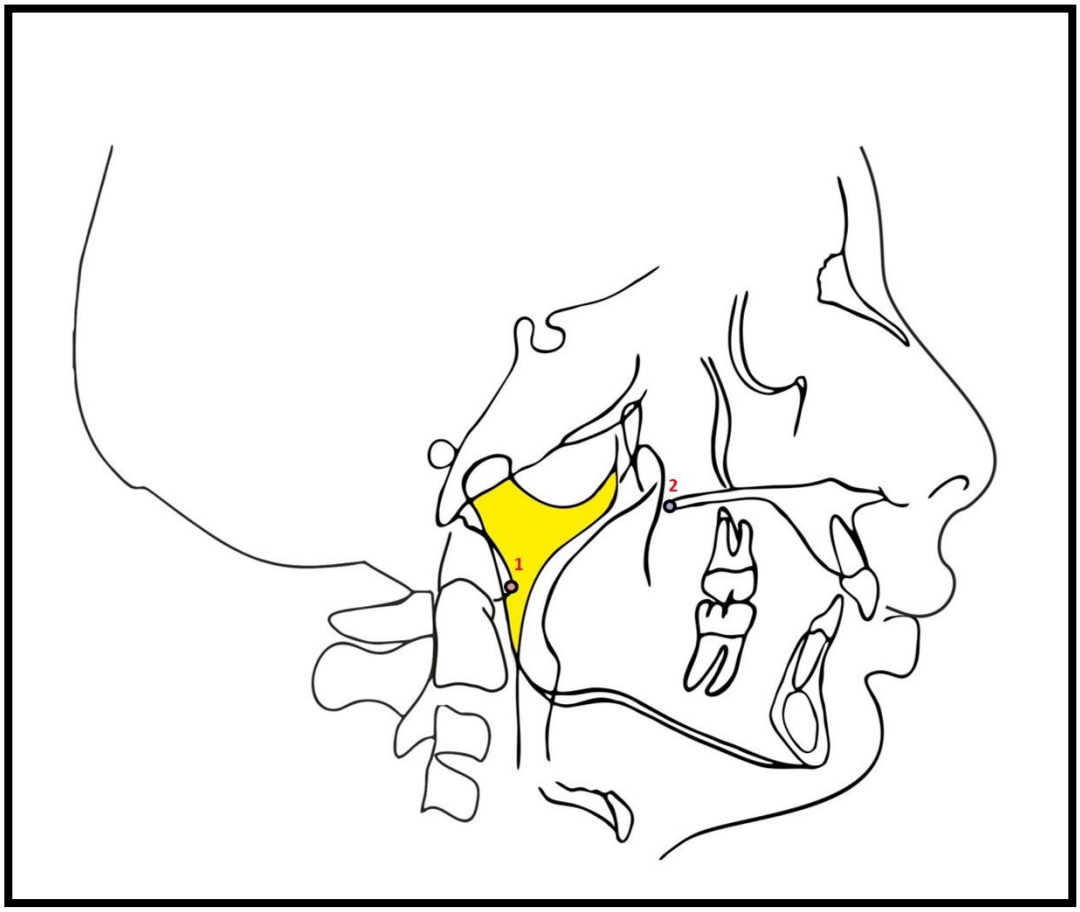


Figure 4: Identification of landmark on MS Paint for sampling: 1. Anterior most point on second cervical vertebrae (C2), **2.** Posterior nasal spine (PNS)

After identification of these landmark on MS paint, image was saved again in JPEG format and transferred to IC Measure software for construction of new landmark Sc, Ad, Ad'.

- **Landmarks identified on IC Measure software**

1. **Point Sc (Centre of Sella turcica):** On IC measure software, over the soft copy of each lateral cephalogram, mid-point of Sella turcica – point Sc was located. It is done by making the two circles touching maximum surface of interior of the posterior and anterior wall. The centres of these two circles are joined together and the centre of this line is considered as centre of the Sella turcica named as Sc. (Fig. 5)

2. **Point Ad and Ad'**

Reference planes and bisector line used for identifying Ad and Ad' (Fig. 6)

1. **Sc-C2:** Line formed by joining point S and point C2.
2. **C2-PNS:** Line formed by joining point C2 and point PNS.
3. **PNS-Sc:** Line formed by joining point PNS and point S.

A triangle is formed joining point Sc, C2, PNS.

4. **Bisector line of angle Sc-PNS-C2:** Bisector of angle Sc-PNS-C2 was dropped on the plane Sc-C2 from PNS.

The nasopharyngeal space is calculated from the PNS to the point falling on S-C2 plane through the bisector of the angle Sc-PNS-C2.

Definition of point Ad and Ad'

Point Ad: Ad is constructed as the anterior most point of the adenoid tissue located on the bisector of angle Sc-PNS-C2 (Fig. 6).

Point Ad': Ad' is constructed as the posterior most point of the adenoid tissue located on the bisector of angle Sc-PNS-C2 (Fig. 6).

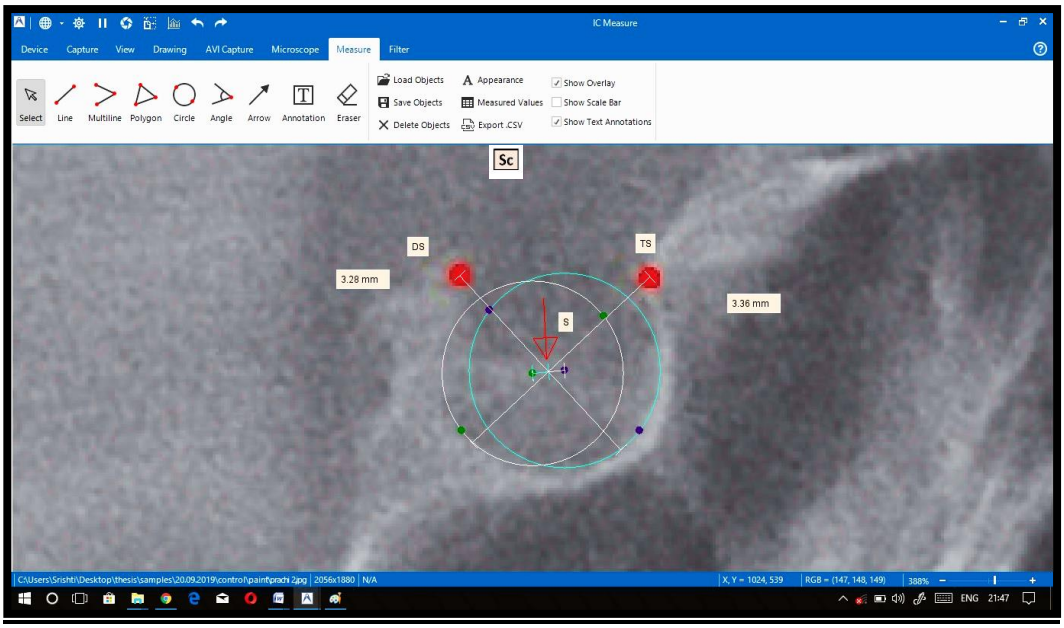


Figure 5: Construction of mid-point of Sella turcica on IC Measure software.

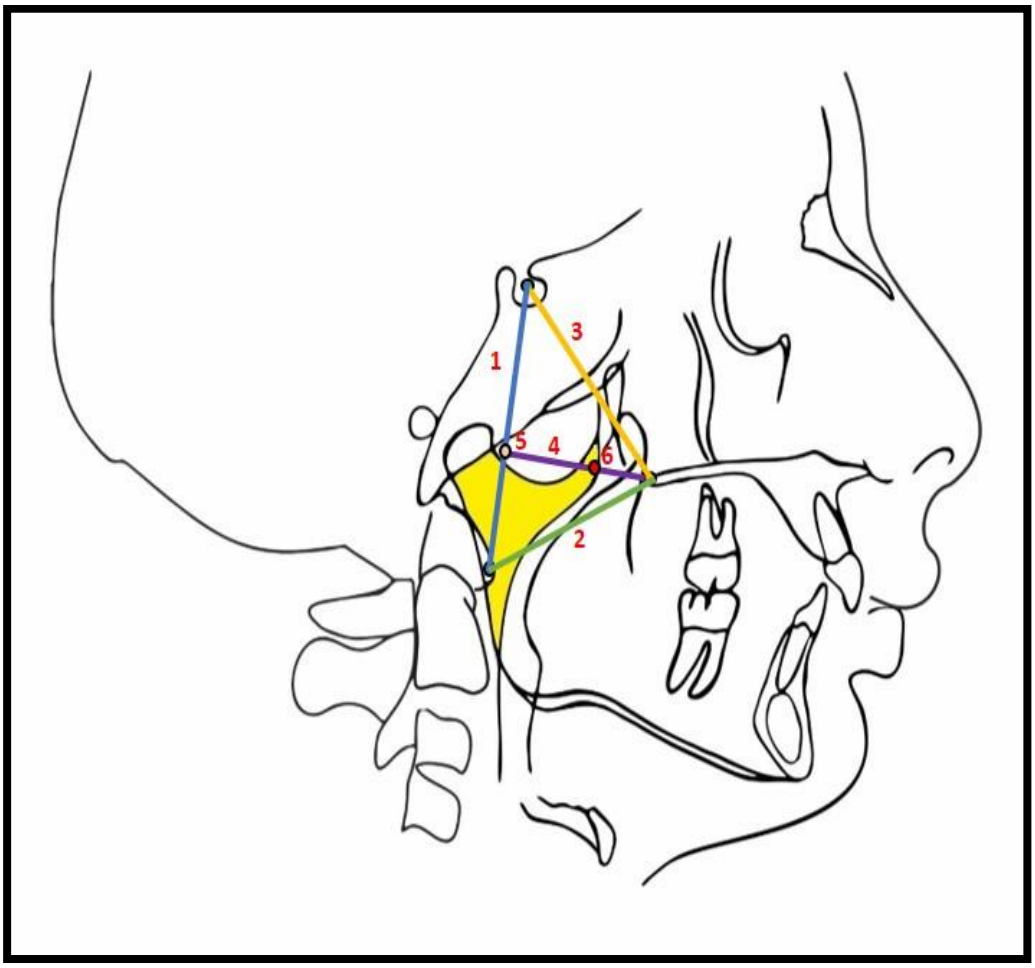


Figure 6: Landmarks and planes for sampling: 1. Sc-C2, **2.** C2-PNS, **3.** PNS-Sc, **4.** Bisector of angle Sc-PNS-C2, **5.** Point Ad, **6.** Point Ad'

A) Calculation of parameter - Percentage coverage of nasopharynx

Amount of adenoidal tissue covering the nasopharyngeal space determines the percentage coverage of nasopharyngeal space. This is the basis of the calculation of obstruction of nasopharyngeal space due to enlarged adenoids.

Calculation: It is calculated mathematically by formula-

$$\text{Nasopharyngeal obstruction \%} = \frac{Distance\ from\ Ad'-Ad}{Distance\ from\ Ad'-PNS} \times 100$$

The subjects who had percentage coverage of nasopharyngeal space of less than 45% was included in control group (Group I) and subjects with more than 45% were included in experimental (Group

II). Subjects who had borderline values were excluded from the study. Final sample size constituted of 100 pre-treatment lateral cephalograms that were divided in two groups as shown in Table 1.

i- Group I (Control): Lateral cephalograms of 50 subjects with normal adenoids.

ii- Group II (Experimental): Lateral cephalograms of 50 subjects with enlarged adenoids.

Table 1: Mean age and percentage coverage of nasopharynx for the groups.

Sample (n=100) (Lateral cephalograms)	**Group I (n=50)** (Control)	**Group II (n=50)** (Experimental)
Mean Age (years)	**12.92±1.56**	**13.64±1.38**
Percentage coverage of nasopharynx (%)	**29.54±8.20**	**54.63±5.91**

LANDMARKS, PLANES AND PARAMETERS USED TO MEASURE DIMENSIONS OF SELLA TURCICA

- **Landmarks identified on MS Paint** (Fig. 7)

1. **Na:** Most anterior aspect of the fronto-nasal suture.
2. **TS:** Slight elevation in front of the Sella turcica on the body of the sphenoid.
3. **DS:** A square portion of bone on the body of the sphenoid posterior to the Sella turcica.
4. **Ba:** Perpendicular projection of the anterior border of foramen magnum (endobasion) on a tangent through the lower contour of the foramen.
5. **C2:** Anterior most point on the second cervical vertebrae.
6. **PNS:** Most posterior aspect of the palatine bone.

After identification of these landmark on MS paint, image was saved again in JPEG format and transferred to IC Measure software for construction of new landmark Sc, Ad, Ad'.

Point Sc: Constructed as mid-point of the bony crypt of Sella turcica. (Fig. 5)

Point Ad: Ad is constructed as the anterior most point of the adenoid tissue located on the bisector of angle Sc-PNS-C2 (Fig. 6).

Point Ad': Ad' is constructed as the posterior most point of the adenoid tissue located on the bisector of angle Sc-PNS-C2 (Fig. 6).

- **Reference lines used to measure dimensions of Sella turcica** (Fig. 8)

1. **DS line:** plane drawn from DS to the anterior limit of sella turcica passing through the point Sc.
2. **TS line:** plane drawn from TS to the posterior limit of sella turcica passing through the point Sc.

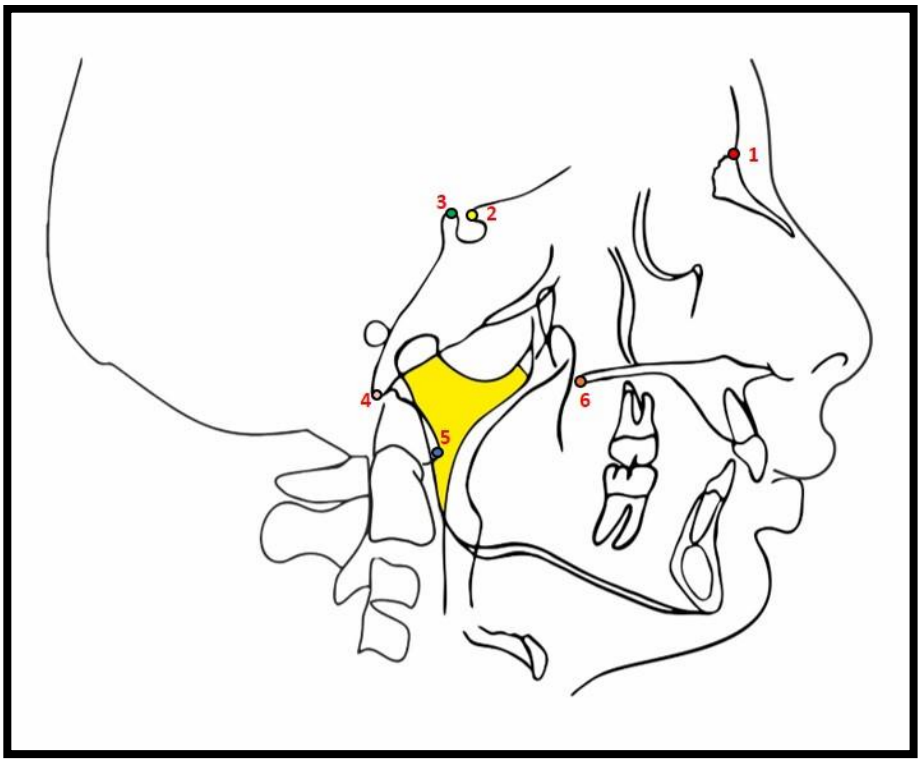


Figure 7: Landmarks used in the study identified on MS Paint. 1. Na, **2.** TS, **3.** DS, **4.** Ba, **5.** Anterior most point on second cervical vertebrae (C2), **6.** PNS

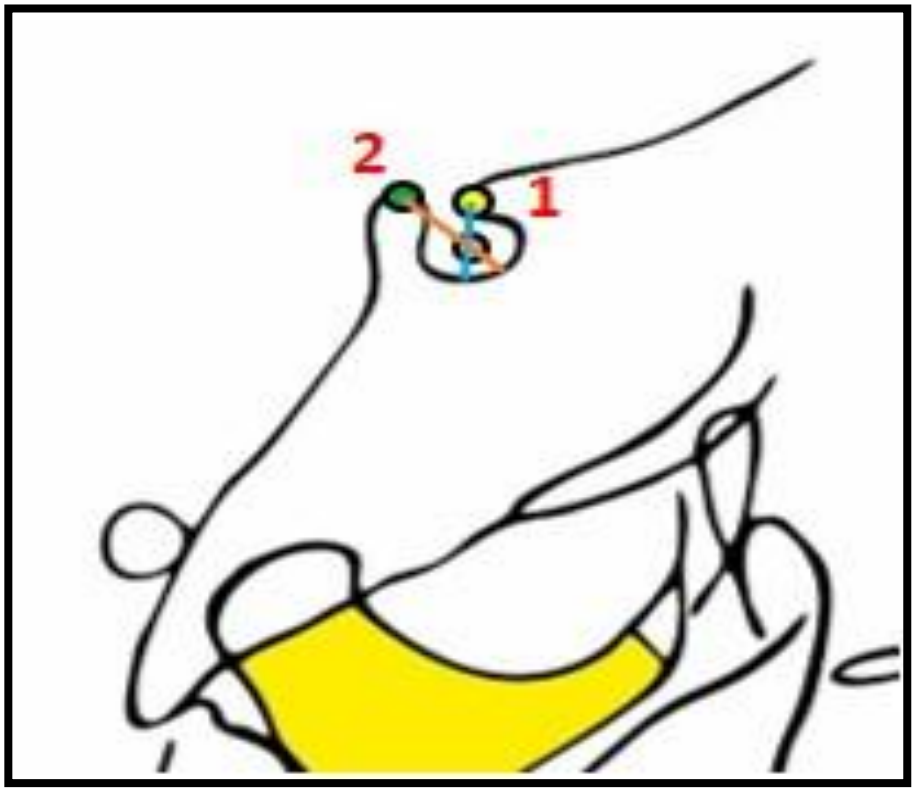


Figure 8: Reference lines to measure dimension of Sella turcica. 1. TS line, **2.** DS line

PARAMETERS USED IN THE STUDY

a) Parameters for determining dimensions of Sella turcica

i) Average diameter of Sella Turcica: Average of the diameters drawn from point DS (Dorsum Sellae) and point TS (Tuberculum Sellae) is considered as the diameter of Sella turcica in the present study.

ii) Average radius of the Sella Turcica (r): The half length of the average diameter gives the average radius of sella for each sample.

Circumference and Area of Sella Turcica was calculated using average radius of Sella turcica.

iii) Circumference of the Sella Turcica (Ⓒ): The circumference of the sella turcica for each sample is mathematically calculated from the average radius of the same by the formula-

$$\text{Circumference } (Ⓒ) = 2\pi r$$

iv) Area of the Sella Turcica (Ā): The area of the sella turcica for each sample is mathematically calculated by the formula:

$$Ā = \pi r^2$$

b) Parameters for determining cranial base angle

i) N-S-Ba: Angle formed between reference line Nasion to Sella and Sella to Basion forms cranial base angle. (Fig. 9)

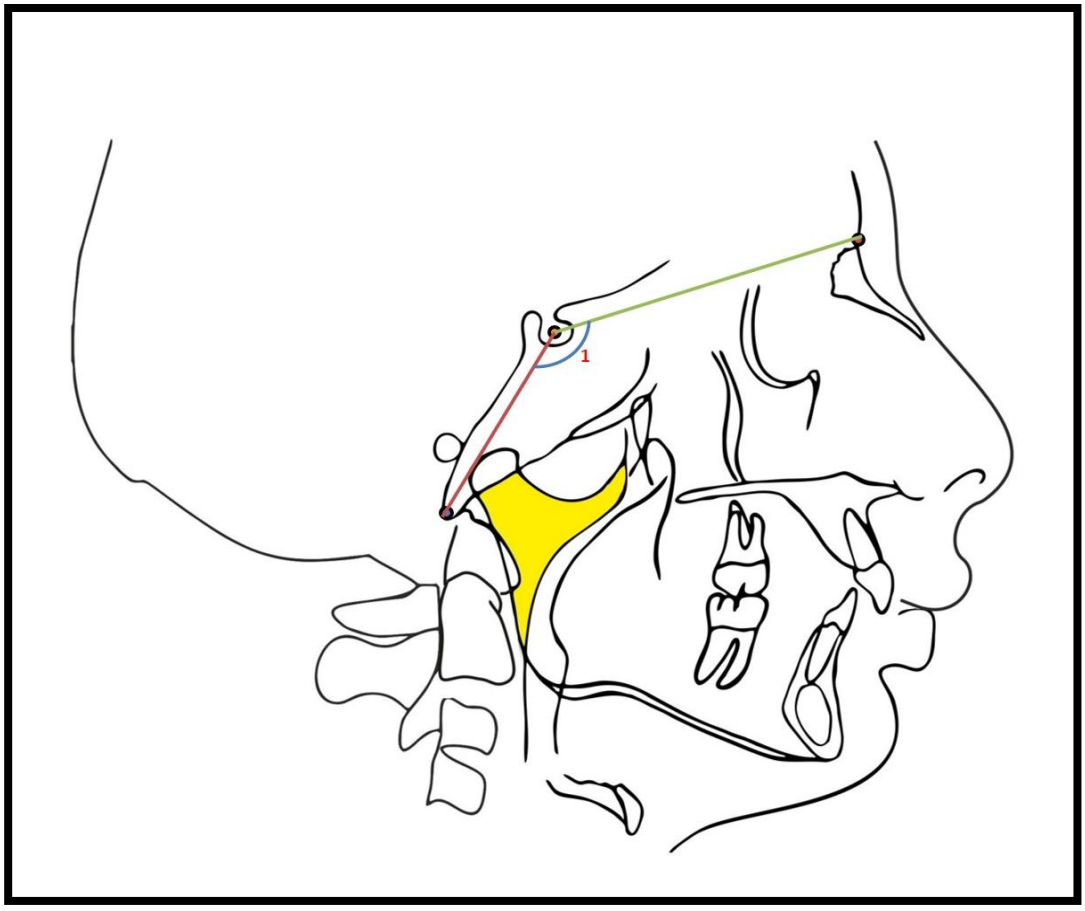


Figure 9: Reference angle to measure flexion of cranial base. 1. Cranial base angle

c) Parameters for determining the morphology of Sella turcica

Visual analysis of shape of Sella turcica was also done on 100 samples. Six shapes of sella turcica has been observed by Axelsson, Storhaug and Kjaer[12] in year 2004. These six shapes are also considered as one of the parameters of the present study. It includes-

- **A.** Normal shape of sella turcica (as per Axelsson, Storhaug and Kjaer)[12] (Fig. 10 A)
- **B.** Oblique anterior wall (Fig. 10 B)
- **C.** Double contour of the floor of sella turcica (Fig. 10 C)
- **D.** Sella turcica bridge (Fig. 10 D)
- **E.** Irregularity (notching) in the posterior part of dorsum sellae (Fig. 10 E)
- **F.** Pyramidal shape dorsum sellae (Fig. 10 F)

Data collected for evaluation of dimension of Sella turcica, cranial base angle and morphology of Sella turcica was subjected to appropriate statistical analysis for further comparison and establishment of various considerations.

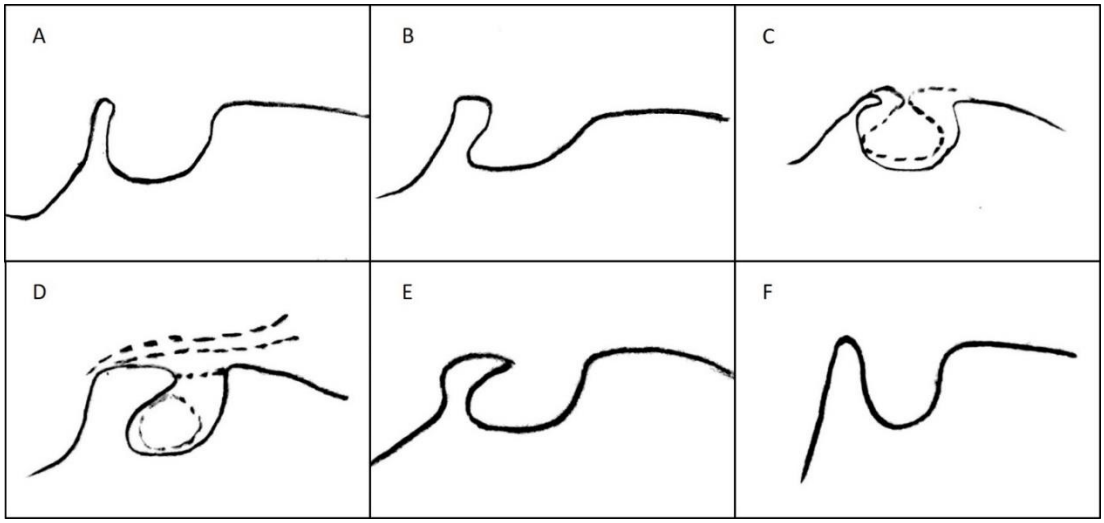


Figure 10: Morphology of Sella Turcica. A. Normal shape of sella turcica **B.** Oblique anterior wall **C.** Double contour of the floor of sella turcica Double contour of the floor of sella turcica **D.** Sella turcica bridge **E.** Irregularity (notching) in the posterior part of dorsum sellae **F.** Pyramidal shape dorsum sellae

RESULT AND OBSERVATION

The study was conducted with the aim to evaluate the dimensional and morphological changes in Sella turcica and flexion of cranial base secondary to nasopharyngeal obstruction due to enlarged adenoids and to find correlation between dimensional changes in Sella turcica with flexion angle of cranial base.

A total of 100 lateral cephalograms of pre-treated patients with age ranging from 9 to 15 years were taken and equally divided in two groups. Group I comprised of lateral cephalograms of patients with normal sized adenoids with mean percentage coverage of 29.54 of nasopharynx. Group II comprised of lateral cephalograms of patients with enlarged adenoids with mean percentage coverage of 54.63 of nasopharynx. Independent student t test was applied for analysing and comparing the two groups.

A total of 11 parameters were taken into consideration to evaluate **dimensions of nasopharyngeal space, flexion of cranial base, dimensions and morphology of sella turcica**.

Table 2 shows the inter-group comparison of different parameters among the two groups using independent 't' test. The Group II, Experimental group, showed significantly lower value (P value = 0.010) between diameter of Sella from dorsum sellae (2.64±0.55) than that of Group I (2.94±0.57). Diameter of Sella from tuberculum sellae shows significantly lower value (P value=0.018) in experimental group (3.37 ±0.527) than control group (3.65 ±0.633). Average diameter of Sella turcica is highly significant lower value (P value = 0.004) in patients with enlarged adenoids (3.01 ±0.462) than patients with normal adenoids (3.30 ±0.519). Average radius of Sella turcica is highly significant lower value (P value = 0.004) in patients with enlarged adenoids (1.50 ±0.231) than patients with normal adenoids (1.65 ±0.259). The Group II showed highly significant lower value (P value = 0.004) between circumference of Sella (9.45 ± 1.45) than that of Group I (10.36 ± 1.63). The Group II showed highly significant lower value (P value = 0.007 in respect to area; P value= 0.009 in respect to cranial base angle) between area of Sella (7.27 ± 2.34) and cranial base angle (129.165± 4.59) than that of area (8.74 ± 2.89) and cranial base angle (131.55 ± 4.36) of Group I. (10.36 ± 1.63). Dimension of nasopharyngeal space was significantly lower value (P

value = 0.019) in Group II (11.27± 1.002) compared to Group I, control group (11.75 ± 0.996). Group II, Experimental group showed very high significant difference (P value = < 0.0001) in respect to adenoidal dimension (6.15±0.834) and percentage coverage of nasopharynx (54.63 ± 5.91) when compared to the adenoidal dimension (3.50 ± 1.108) and percentage coverage of nasopharynx (29.54 ± 8.20) of Group I, Control group.

Table 3: Intergroup comparison between different shape of Sella turcica

S.No.	Shape of Sella Turcica	Group I (Normal adenoids)	Group II (Enlarged adenoids)	P value
1.	Normal Sella Turcica **(A)**	19	8	0.012*
		38.0%	16.0%	
2.	Oblique anterior wall **(B)**	5	3	0.357
		10.0%	6.0%	
3.	Double contour of the floor **(C)**	11	12	0.500
		22.0%	24.0%	
4.	Sella Turcica bridge **(D)**	0	0	NA
		0.00%	0.00%	
5.	Irregularity (notching) in the posterior part of the Sella Turcica **(E)**	11	9	0.402
		22.0%	18.0%	
6.	Pyramidal Shape dorsum sellae **(F)**	2	18	<0.001***
		4.0%	36.0%	

*(S)= Significant difference; ***(VHS)= Very highly Significant difference; >0.05= No Significant difference; NA= Not Available

Table 3 shows the inter-group comparison between different shape of sella turcica using Chi square test. Normal shape of Sella turcica (38.0%) was most prominent in Group I (Control), followed by double contour of the floor (22.0%) and irregularity (notching) in the posterior part of the Sella turcica (22.0%). The least prevalent in Group I (Control) was pyramidal shape dorsum sellae (4.0%).

Pyramidal shape dorsum sellae (36.0%) was most dominant shape found in Group II (Experimental), followed by double contour of the floor of Sella (24.0%), irregularity (notching) in the posterior part of the Sella turcica (18.0%) and normal shape of Sella turcica (16.0%). The least prevalent in Group II (Experimental) was oblique anterior wall (6.0%).

Significant differences were seen in the normal shape of Sella turcica and pyramidal Shape dorsum sellae when compared groupwise using Chi square test as $p<0.05$.

No Significant differences were seen in presence or absence of Oblique anterior wall, double contour of the floor of Sella turcica, irregularity (notching) in the posterior part of the Sella turcica when compared groupwise using Chi square test as $p>0.05$.

None of the cases in both the groups were having Sella turcica bridge.

Table 4: Correlation of Cranial base angle with different parameters used in the study.

S.No.	Parameters	Pearson Correlation test	Significance
1.	Diameter from DS (mm)	0.245	*0.014
2.	Diameter from TS (mm)	0.204	*0.042
3.	Average diameter (mm)	0.257	**0.010
4.	Average radius (mm)	0.258	**0.009
5.	Circumference of Sella Turcica (mm)	0.257	**0.010
6.	Area of Sella Turcica (mm^2)	0.266	**0.007
7.	Nasopharyngeal Space (mm)	0.153	0.129
8.	Adenoid dimension (mm)	-0.206	*0.040
9.	Percentage Coverage of Nasopharynx (%)	-0.248	*0.013

*S= Significant difference; **S= Highly Significant difference; ***S= Very highly Significant difference; >0.05 = No Significant difference

Table 4 shows correlations between cranial base angle with different parameters used in the study. The Dimensions of Sella turcica and nasopharyngeal space shows positive correlation with cranial base angle while the adenoid dimension and percentage coverage of nasopharynx shows negative correlation with cranial base angle. Diameter from DS, diameter from TS, Adenoid dimension and percentage coverage of nasopharyngeal space shows significant difference with weak correlation. Average diameter of Sella tucica, average radius of Sella turcica, Circumference of Sella turcica and Area of Sella turcica shows high significant difference with weak correlation whereas nasopharyngeal space shows significant difference with very weak correlation.

Adenoid dimension and percentage coverage of nasopharynx shows negative correlation with cranial base angle. Both of the show significant different with weak correlation.

Table 5: Correlation of morphology of Sella turcica with adenoid dimension.

S. No.	Morphology of Sella Turcica	Pearson Correlation test	Significance
1.	Normal Sella Turcica **(A)**	-0.453	***0.000
2.	Pyramidal Shape dorsum sellae **(F)**	0.291	**0.003

**S= Highly Significant difference; ***S= Very highly Significant difference

Table 5 shows correlation of morphology of Sella turcica with adenoid length. Normal shape of Sella Turcica shows negative correlation with adenoid dimension and is very highly significant with moderate correlation while pyramidal shape of dorsum sellae shows positive correlation and is highly significant with weal correlation.

DISCUSSION

Nasopharyngeal area is an important part of oro-facial capsule, and soft tissue of this region may have an important bearing on growth of adjoining skeletal structures. It was believed and expressed, that obstruction due to adenoids might influence the developing facial conformity. Normally, the nasopharynx enlarges to accommodate the growing adenoids, thus maintaining a patent nasopharyngeal airway. Any imbalance in this may result in reduced patency and nasopharyngeal obstruction which might influence the form of adjoining skeletal structures. At times this is compensated by the variations in natural head position, ranging between extension and flexion due to altered respiratory pathway[3].

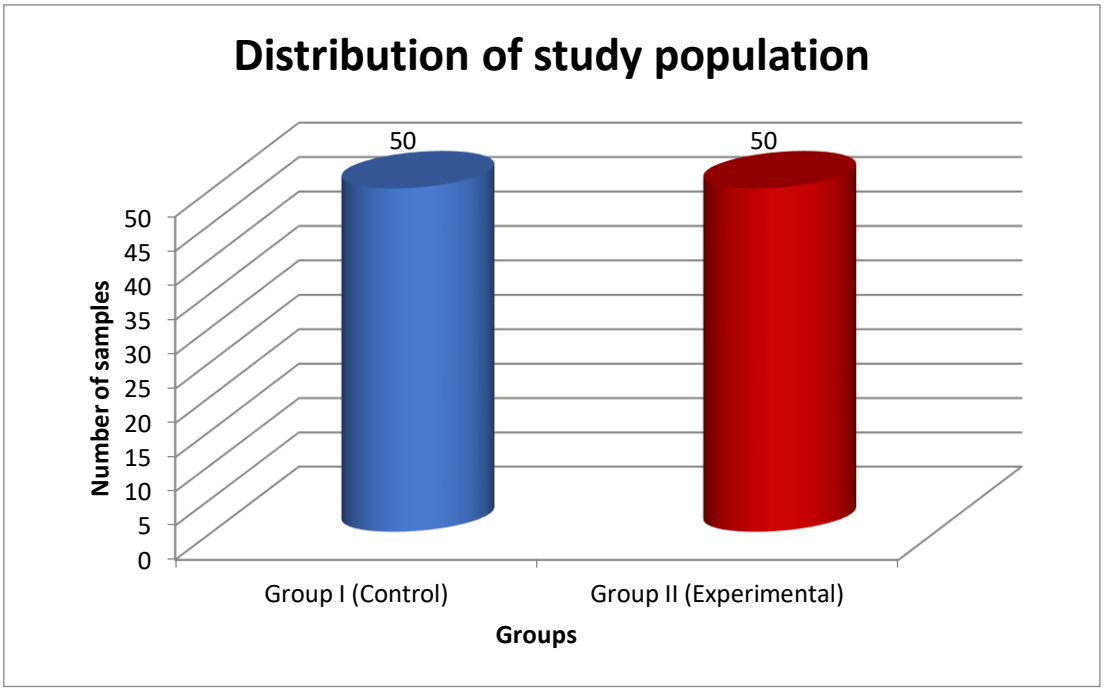
Extension of the head for the shift from nasal to mouth breathing results in anterior and ascending displacement of the occipital condyles on the superior articular surfaces of the first vertebrae, Atlas. This causes the horizontal line of sight of the orbits to be angled upward, with resultant shift of the visual field, needed for postural compensation. Hence extension of the head in relation to the cervical vertebral column was correlated with a larger cranial base angle which can be further correlated with the one of the important land-mark in Orthodontics, Sella turcica[4]. The Alteration in size of the Sella turcica had been seen in pituitary pathologies. The morphology of the Sella was described subjectively and qualitatively, and alterations were categorized into different types such as circular, oval, flat, shallow and J-shaped. **Becktor et al. (2000)**[6] and **Jones et al. (2005)**[7] found increased frequency of a Sella turcica bridge in patients with severe craniofacial deviations. However, literature is not available to establish relation between dimension of Sella turcica and nasopharyngeal obstruction. The role of enlarged adenoids in altered dentofacial morphology is well established but till date no studies have been conducted to correlate dimensional changes in Sella turcica due to enlargement of adenoids. Therefore, it was decided to evaluate the dimensional and morphological changes of Sella turcica and alteration in cranial base angle secondary to nasopharyngeal obstruction due to enlarged adenoids.

This cephalometric study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow to evaluate the dimensional changes in Sella turcica and flexion of cranial base secondary to nasopharyngeal

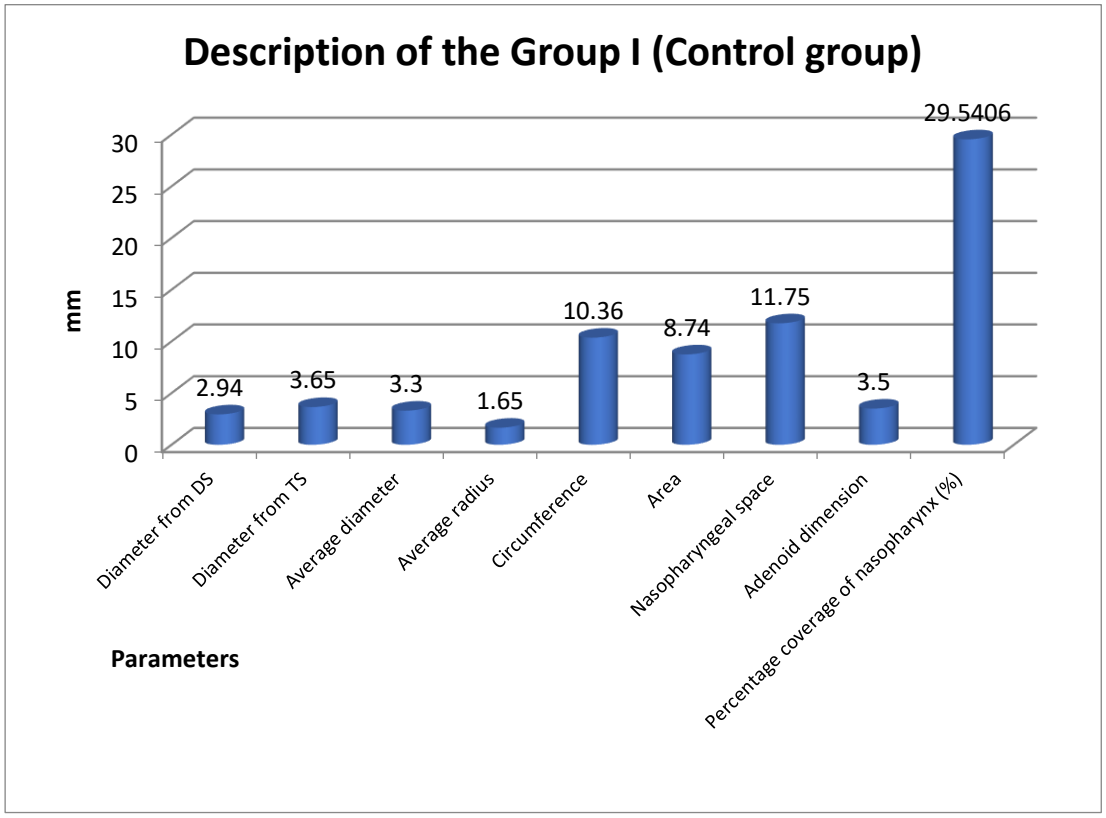
obstruction due to enlarged adenoids and to find correlation between dimensional changes in Sella turcica with flexion angle of cranial base. Sample for the present study comprised of 100 lateral cephalograms of pre-treated patients with age ranging from 9 to 15 years which are equally distributed amongst the 2 groups with 50 sample in each group. The sample was selected and divided into 2 groups with 50 samples in each group after assessment of percentage coverage of nasopharynx (adenoid length/nasopharyngeal space). For its assessment the exact center of Sella turcica (Sc) has to be determined. It is done by making the two circles touching maximum surface of interior of the posterior and anterior wall. The centres of these two circles are joined together and the centre of this line is considered as centre of the Sella turcica named as Sc. This method of measuring centre of a circular or elliptical body is also used by **Khanna et al. (2011)**[35] in their study. The advantage of this method is that it is efficient in calculating the dimensions of Sella turcica rather than arbitrarily marking the centre of Sella turcica. Considering Sella as an elliptical/oval body – diameter, circumference and area of Sella turcica is measured. A more reliable and new method to measure the dimension as well as to mark the centre of Sella turcica can be obtained through this study.

The group I (n=50) represents the patients with normal adenoids having percentage coverage of nasopharynx of less than 45 while the Group II (n=50) represents the patients with enlarged adenoids having percentage coverage of nasopharynx equal to or more than 45. Graph 1 shows the equal distribution of samples in 2 groups.

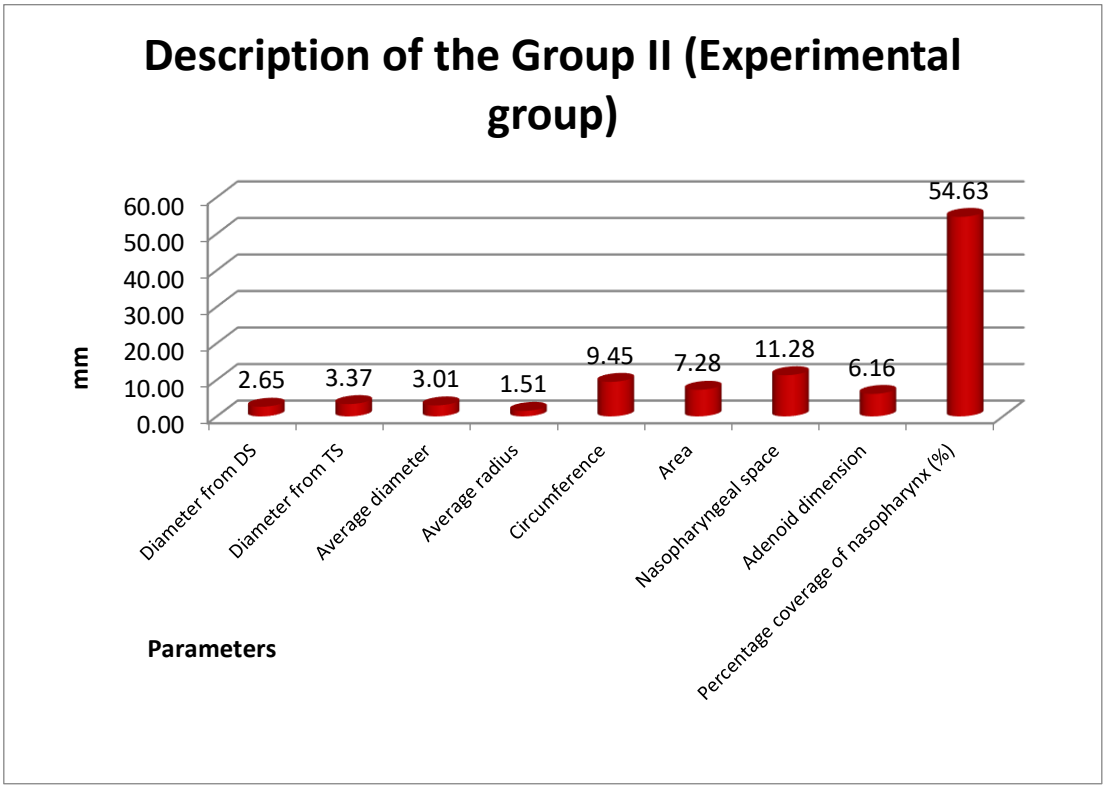
A total of ten parameters were considered in the present study, six parameters evaluating dimensions of Sella turcica (diameter from dorsum sellae, diameter from tuberculum sellae, average diameter, average radius, circumference, area), three parameters evaluating dimensions of nasopharyngeal space (nasopharyngeal space, adenoid dimension, percentage coverage of nasopharynx) and one parameter for evaluation of cranial base angle (Graph 2, 3,4). Also, morphology of Sella turcica was determined. Data obtained for both the groups was subjected to appropriate statistical analysis.



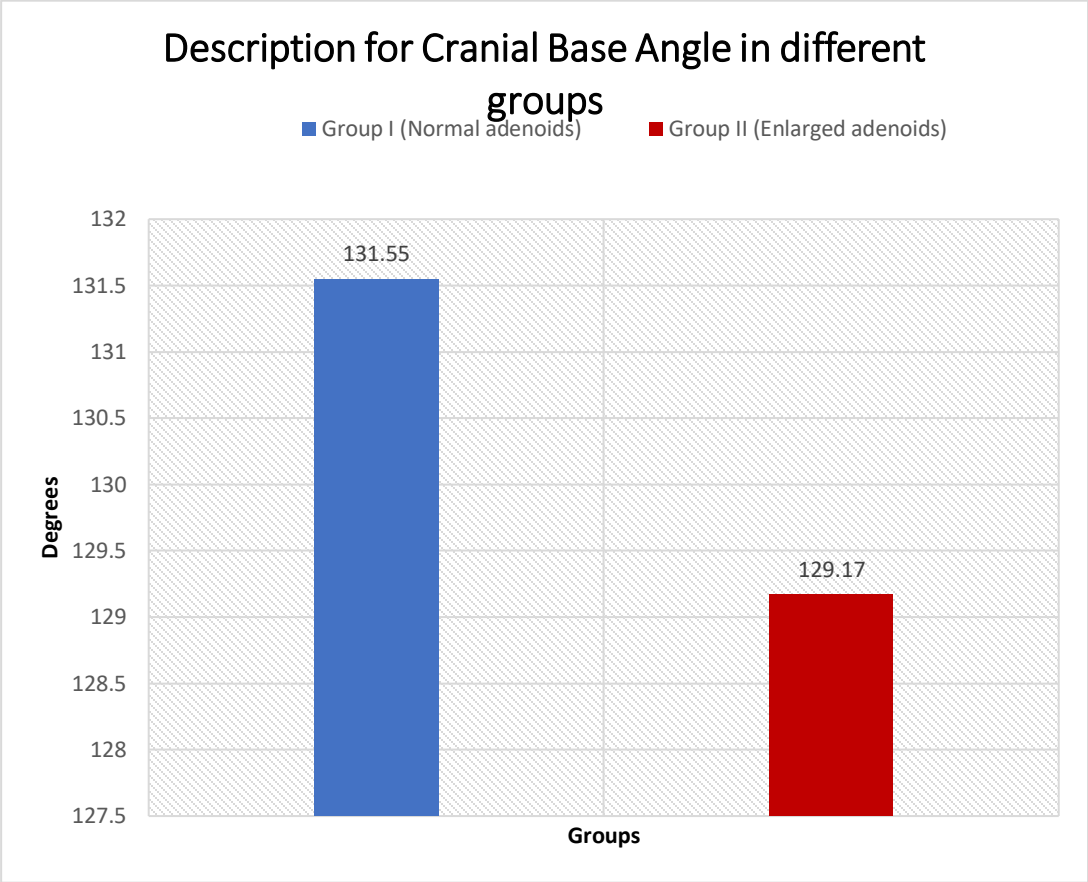
Graph 1: Distribution of study population.



Graph 2: Description of Group I (Control).



Graph 3: Description of Group II (Experimental).

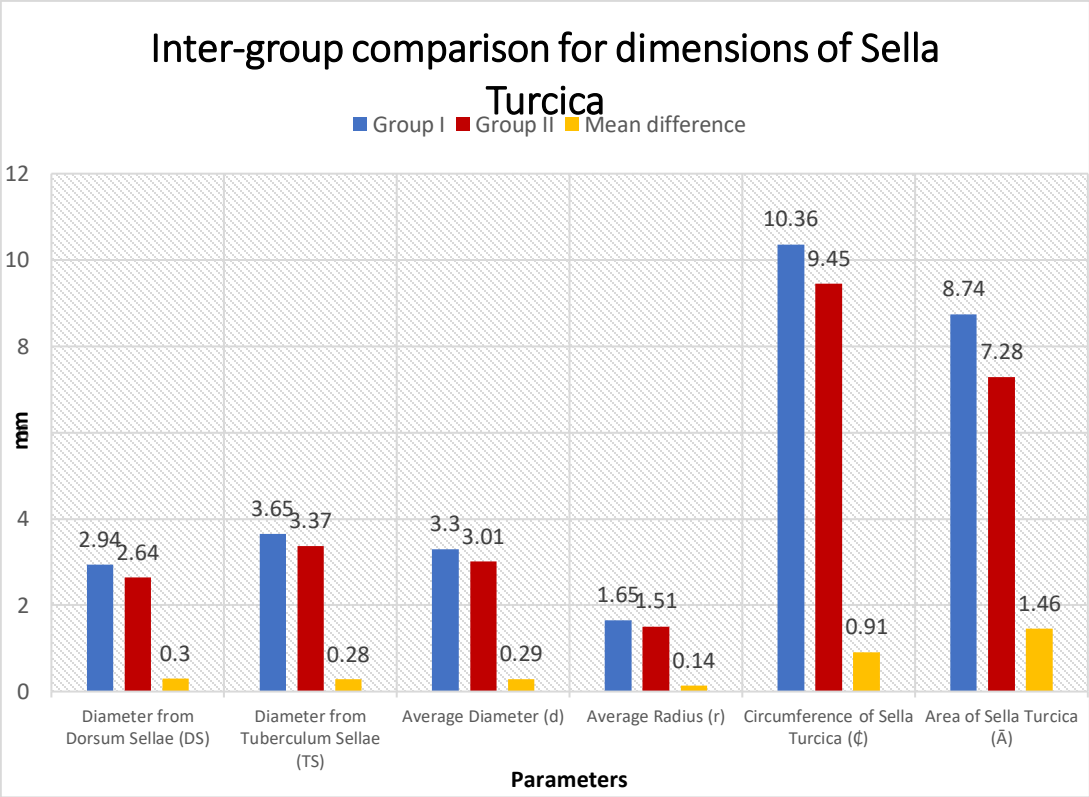


Graph 4: Description of cranial base angle in different groups.

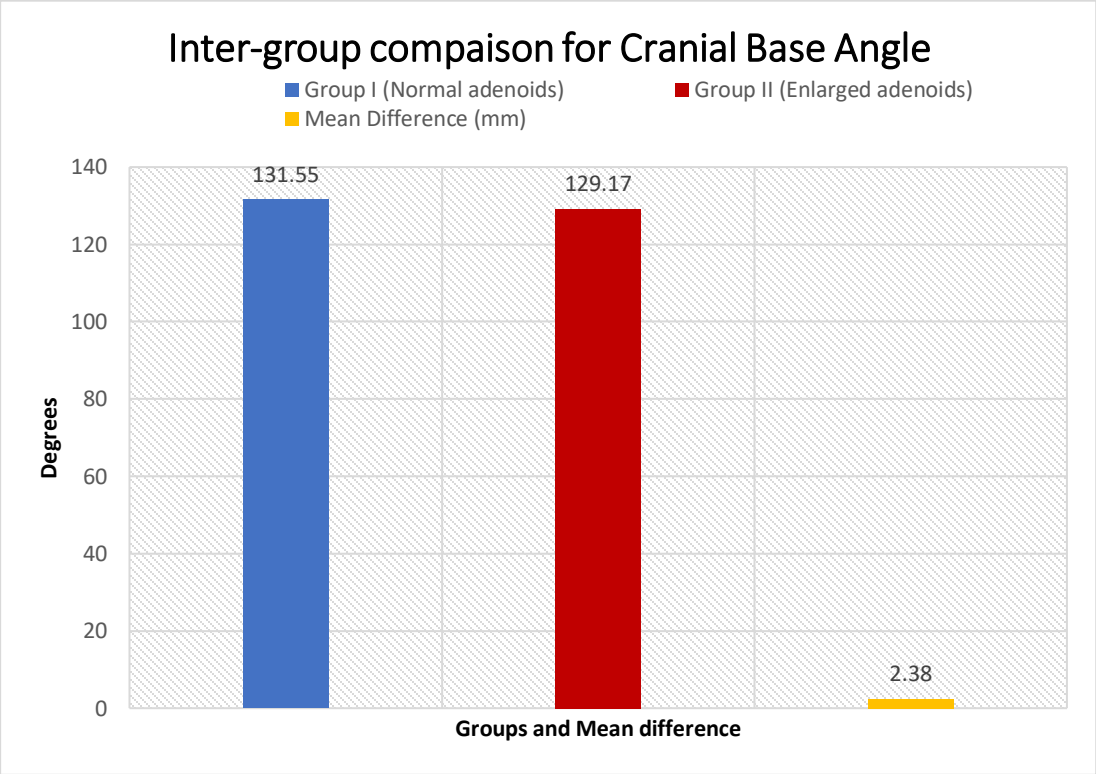
The results of the present study showed a statistically significant decrease in dimensions of Sella turcica (significant in diameter from dorsum and tuberculum sellae with P value of <0.05, highly significant in average diameter, average radius, circumference and area with P value of <0.01 in Group II in comparison to Group I (Graph 5). Cranial base angle showed highly significant decrease with P value of <0.01 in Group II in comparison to Group I (Graph 6). Significant decrease in nasopharyngeal space with P value of <0.05 and very highly significant increase in adenoid dimension and percentage coverage of nasopharynx with P value of <0.001 was seen in Group II in comparison to Group I (Graph 7).

On observing the morphology of the Sella turcica, in the present study suggested that there was very high significant difference between the two groups for pyramidal shape dorsum Sella and significant difference for normal shape Sella turcica. Pyramidal shape dorsum sellae was found to

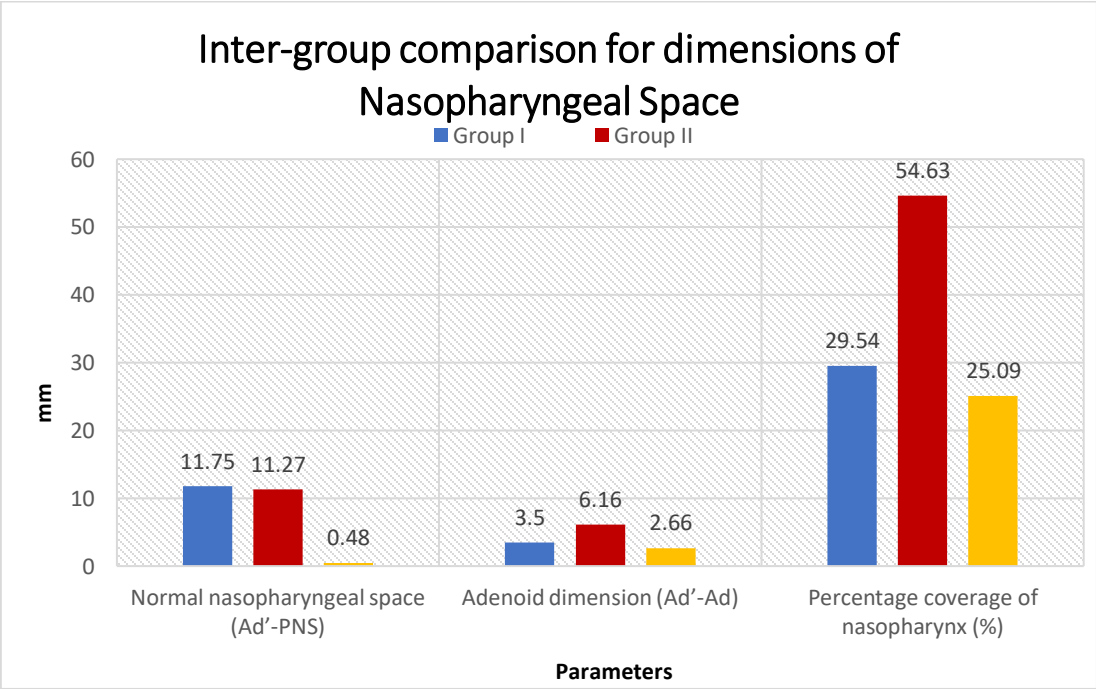
be more prominent with P value of <0.001 in Group II (Experimental) when compared with the Group I (Control). Normal shape of Sella turcica with P value of <0.05 was most commonly seen in Group I in comparison to Group II (Graph 8).



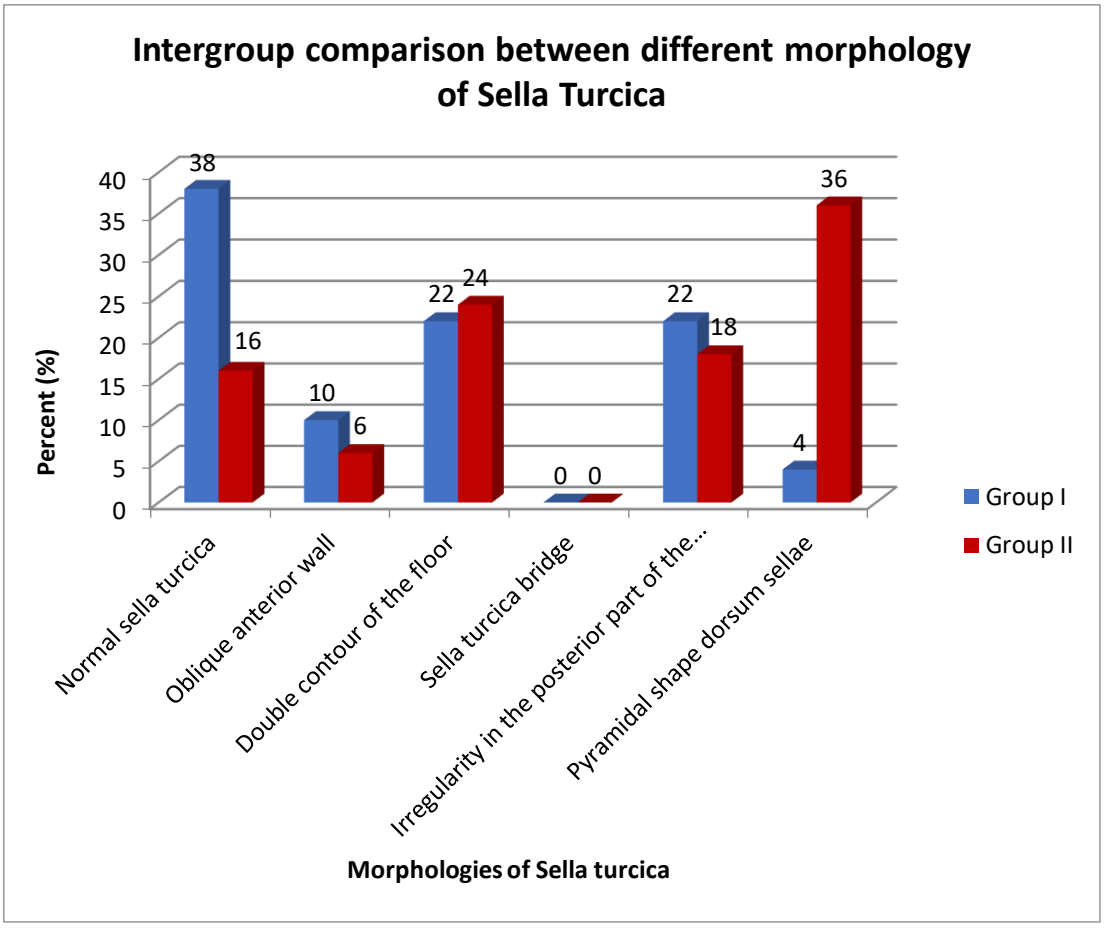
Graph 5: Inter-group comparison for dimensions of Sella turcica.



Graph 6: Inter-group comparison for Cranial base angle.



Graph 7: Inter-group comparison for dimension of nasopharyngeal space.



Graph 8: Intergroup comparison for different morphologies of Sella Turcica.

Fujioka et al. (1979)[14] evaluated ratio between adenoidal length/nasopharyngeal length in 92 subjects who had symptoms related to enlarged adenoids. They calculated adenoidal dimension as the perpendicular distance drawn from the point of maximal convexity along the inferior margin of adenoid shadow to a line drawn along the straight part of the anterior margin of the basiocciput. The nasopharyngeal space is calculated as distance between the posterior-superior edge of the hard palate and antero-inferior edge of the spheno-basioccipital synchondrosis. When the synchondrosis is not clearly visible another point is derived as the point of crossing of the posteroinferior margin of the lateral pterygoid plate and the floor of the bony nasopharynx. The mean AN ratio at age of 13.6 years came to be 0.458 ± 0.1521, at age of 14.6 years came to be 0.435 ± 0.1436. However, we calculated adenoidal dimension and nasopharyngeal length in a different manner and expressed it as percentage coverage of nasopharynx with adenoids. The mean age of our sample was similar to their study (13.64 ± 1.38) and we found mean value of percentage coverage of nasopharynx as 54.63 ± 5.91. On multiplying the ratios of above mentioned study by 100, it can be seen that their ratios can be expressed as ranging from 43.5% to 45.8%. This range is similar to referenced percentage coverage of nasopharynx (>45%) selected for inclusion of subjects in Group II (experimental) in present study. In another study done by **Samy Elwany (1987)[19]**, the AN ratio was measured in children before considering them for adenoidectomy. Similar method as Fujioka et al[11] was used to evaluate the AN ratio. The mean AN ratio for children selected for adenoidectomy was 0.713. On multiplying by 100, it can be seen that subjects with 71.3% coverage of nasopharynx by adenoid were asked to undergo adenoidectomy.

Axelsson et al. (2004)[26] conducted a study with the purpose to assess the normative cephalometric standards of size (length, diameter and depth) and morphology of the Sella turcica in Norwegians males and females with age range between 6-21 years using lateral cephalogram. The calculated variables were length, depth and diameter of Sella turcica. The antero-posterior longest distance from the tuberculum sellae to a point on the posterior inner wall of Sella turcica determines the diameter in their study. The mean diameter with standard deviation in males at age of 9 years was 10.1 ± 1.1 while 10.2 ± 1.3 in females, at age of 12 years was 10.6 ± 1.2 in males while 10.5 ± 1.2 in females and at age of 15 years was 11.0 ± 1.0 in males and in females was 11.1 ± 1.1. These age groups are similar to age range of sample of our study. On comparison, control group of the present

study had Sella diameter from tuberculum sellae (TS) as 3.65 ± 0.63 mm, from dorsum sellae (DS) as 2.94 ± 0.57 passing through the constructed centre of Sella (Sc) and average diameter of Sella as 3.30 ± 0.53. The decrease value of present study can be attributed to difference in way of calculation of Sella diameter. **Axelsson et al. (2004)[26]** found all the morphological shape in their study, with 71% of male groups and 65% of female groups had normal morphology of Sella turcica. In present study normal Sella turcica was seen to be 38% in the control group. **Alkofide (2007)[9]** evaluating size and shape of Sella turcica in skeletal Class I, Class II and Class III in Saudi subjects, noticed a significant difference in diameter size between Class II and Class III subjects with mean of 13.4 ± 1.68 and 14.6 ± 2.08 respectively. There was no significant difference found between the length and depth of the Sella in different skeletal types. **Yasser et al. (2010)[10]** evaluating size and and morphology of Sella turcica in Iraqi adults with different skeletal type Class I, Class II and Class III, showed no statistical difference in size of Sella turcica (length, depth and diameter) in different skeletal malocclusions. Mean value of diameter of Sella turcica (longest antero-posterior distance from TS to posterior wall of Sella turcica) in males and females respectively were 12.30 ± 1.41, 11.70 ± 0.91 in Class I malocclusion, 12.41 ± 1.53, 12.39 ± 1.48 in Class II malocclusion and 12.71 ± 1.42, 12.30 ± 1.43 in Class III malocclusion. Normal shape of Sella turcica was most prominent in skeletal Class I (70%), skeletal Class II (80%) and skeletal Class III (80%) followed by double contour of floor in skeletal Class I (14%), irregularity (notching) in posterior part of dorsum sellae (6%) in skeletal Class II and double contour of floor of Sella turcica (10%) in skeletal Class III. The least prevalent morphology was low Sella turcica in skeletal Class I (2%), Sella turcica bridge in skeletal Class II (2%) and irregularity (notching) in posterior part of dorsum sellae (3.3%), oblique anterior wall of Sella (3.3%), pyramidal shape dorsum sellae (3.3%) in skeletal Class III. **Sathyanarayana et al. (2013)[36]** conducted a similar study to evaluate the size (length, depth and diameter) and morphology of Sella turcica in different skeletal patterns among South Indian population. Significant difference was found in diameter of the Sella turcica (longest antero-posterior distance from TS to posterior wall of Sella turcica) in different skeletal malocclusions. Mean value was found to be 10.9 ± 1.414 in Class I malocclusion, 10.8 ± 1.352 in Class II malocclusion and 11.5 ± 0.978 in Class III malocclusion. Significant reduction in diameter was also noted in younger age groups (9-14 years) with mean value of 10.9 ± 1.30 when compared with older group (15-27 years) having mean value of 11.3 ± 1.25. Normal shape of Sella turcica was

most prominent in skeletal Class I (75%), skeletal Class II (60%) and skeletal Class III (48%). The least prevalent morphology was pyramidal shape in skeletal Class I (2%), Sella turcica bridge in skeletal Class II (3%) and double contour of floor of Sella turcica (7%), oblique anterior wall of Sella (7%), pyramidal shape dorsum sellae (7%) in skeletal Class III. In another study done by **Yasin et al. (2017)[43]** to evaluate the size and shape of the Sella turcica in patients with different vertical growth patterns, they found significant difference found in diameter of the Sella turcica in all the three groups with mean value of 13.38 ± 1.67 in low angle cases, 12.14 ± 1.63 in average angle and 13.46 ± 1.60 in high angle cases. Normal Sella shape was most prevalent in low angle group (50%), average angle (59.4%) and high angle group (65.6%). Least prevalent was irregular dorsum sellae (9.4% and pyramidal shape dorsum sellae (9.4%) in low angle cases, Sella turcica bridge (3.2%) in average angle cases and low Sella turcica (3.1%) in high angle cases. In above mentioned studies by **Axelsson et al (2004)[26] , Alkofide et al (2007)[9], Yasser et al (2010)[10], Sathyanarayana et al (2013)[36] and Yasin et al (2017)[43]** had drawn a line from tuberculum sellae (TS) that covered the longest distance but might not pass through centre of Sella. As we know Sella is not geometrically a circle or sphere, hence to calculate the centre of Sella, we had drawn two circles and a line was drawn from the centres of these two circles. The mid-point of that line was considered as centre of Sella turcica (Sc) (Fig. 11). Mathematically, our method will be more accurate as far as location of centre of Sella is concerned. Also, marking of diameter will be more accurate from tuberculum sellae (TS) and dorsum sellae (DS) to the other side of the wall of Sella turcica passing through the centre, Sc. Further, taking average of diameter from dorsum sellae (DS) and tuberculum sellae (TS) will be better than taking diameter from tuberculum sellae (TS) only.

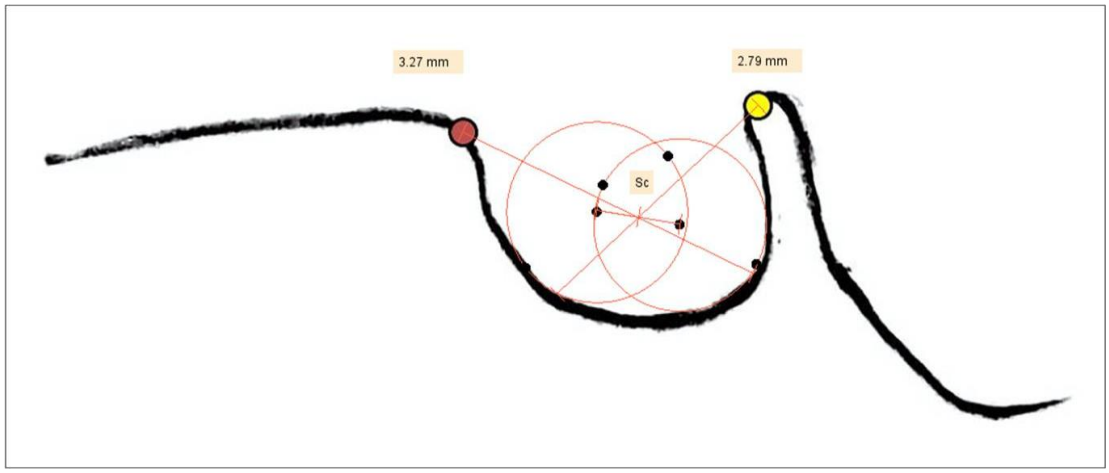


Figure 11: Location of centre of Sella turcica and measurement of diameter of Sella turcica.

None of the studies included a group with craniofacial deformity or any pathology or nasopharyngeal obstruction. However, **Axelsson et al. (2004)**[27] in their another study compared size (length, depth and diameter) and morphology of Sella turcica in subjects with Williams syndrome to control group. They found there was statistically significant decrease in dimension of Sella turcica in Williams syndrome in comparison to control. The mean diameter from tuberculum Sella decreased to 9.6 ± 1.4 in males while 10.1 ± 0.9 in females at age of 11-13 years and 9.8 ± 1.6 in males and in females was 10.8 ± 1.9 at age 14-16 years. In males with WS, the most prevalent morphological aberrations were irregularities of the posterior part of the dorsum sellae (42%) and normal shape of Sella turcica (42%) while in females with WS, the most prevalent morphological aberrations were irregularities of the posterior part of the dorsum sellae (43%), followed by more than one type of morphology (41%). The least prevalent Sella morphology in WS was oblique anterior wall (8%), low Sella turcica (8%) and pyramidal shape dorsum sellae (8%) in males whereas low Sella turcica (14%) and Sella turcica bridge (11%) in females. Though direct comparison was not possible with this study, but this study suggest that Sella diameter is altered in Williams syndrome which includes craniofacial asymmetry. In our study the Sella diameter measured was reduced in subjects with nasopharyngeal obstruction which have resulted in reduction in average radius, area and circumference of Sella turcica. In our study the most prevalent morphological aberration was pyramidal shape dorsum sellae (36%) followed by double contour of the floor (24%) in patients with compromised nasopharyngeal space. Another study by **Inger Kjaer (2015)**[39] showed alteration in morphology of Sella in different pathologies. He described anterior wall of the Sella turcica is deviant and partly absent while posterior wall is normal in a condition called Holoprosencephaly. Also, he noted diminutive size of Sella in the same condition. In Trisomy 21 or Down's syndrome he noted that the anterior wall of the Sella turcica is affected from a slight depression in the lower aspect of the anterior wall to more severe cases where the anterior wall is completely separated from the posterior wall. In Chondrodystrophy, Sella turcica was enlarged and the inner contour of Sella was uneven. Thus, it can be suggested that morphology of Sella turcica was influenced by pathologies or asymmetries in adjoining structures. The exact reason for the change in morphology of Sella turcica in Group II is not known but these remodelling changes at the floor and posterior wall of Sella turcica can be the reason for evident pyramidal

shaped dorsum sellae in enlarged adenoids patients. Though size and shape of Sella turcica had been assessed in various studies but not as response to alteration in nasopharyngeal dimension.

Another parameter considered in the present study was cranial base angle. Fusion along the spheno-occipital synchondrosis is believed to be responsible for cranial base flexion, which develops in concert with the development of the upper airway and the ability to vocalize. The cranial base angle is measured at three points antero-posteriorly and can be easily identified from cephalometric images, the most commonly used cephalometric landmarks are the Nasion, Sella turcica and Basion. Cranial base influences craniofacial morphologies. Any change in anterior or posterior cranial base or any change in cranial base angle will affect the maxilla or mandible which in turn will affect the craniofacial growth. Flexion of cranial base is generally measured through angle formed by S-Na-Ba. Many authors have argued about the cranial base relation and dentofacial structure. In present study the cranial base angle was significantly decreased in Group II (experimental) in comparison to Group I (control). Within the limitations of present study, it can be suggested that this could be result of compensatory adaptation of bringing the mandible forward in response to nasopharynx obstruction due to enlarged adenoids. Even in pseudo Class III there is forward positioning of mandible. **Klocke et al. (2002)[23], Nie (2005)[30], Hasan et al. (2013)[37]** conducted studies and found that N-S-Ba angle was the lowest in Class III, greatest in Class II, and intermediate in Class I.

The possible explanation for results of present study can be explained. In order to maintain the life, the patency of the airway has to be maintained which is the primary goal for existence of life. Thus, in such cases it could be possibly be attained by altering the posture of the head or moving the mandible forward. This extension of head and decrease in cranial base angle because of forward positioning of mandible will relieve nasopharynx obstruction due to enlarged adenoids. The Sella dimension in our study was found to be decreased in the compromised nasopharyngeal space. Sella is part of the basisphenoid bone and the flexural angle or cranial base angle is also measured from the mid-point of Sella turcica. Hence, as alteration in cranial base angle occurs in nasopharyngeal obstruction, there is a high probability that the dimension of the Sella turcica will also be affected. Many studies like **Melsen (1974)[13], Kjaer (2015)[39], Pigolkin et al. (2016)[41]** have suggested

remodelling in posterior wall and floor of Sella turcica. Since anterior wall of Sella forms early in age with anterior cranial base, there is comparatively less changes can observed during growing period secondary to any pathologies **(Melsen, 1974)[13]**. The posterior wall and floor of Sella undergoes remodelling upto the later stages of life. This hypothesis was supported by **Kjaer (2015)[39]** who conducted the study on Sella turcica of prenatal and postanatal cranial base of subjects with different pathologies and **Pigolkin et al. (2016)[41]** after conducting a study on subjects with age range of 22-74 years. **Latham (1972)[12]** suggested a reason for this remodelling. According to him, dorsum sellae remained cartilaginous for at least the first 5 years after birth, and during the first 10 years there was remnants of cartilage present near dorsum sellae. With continuing growth at the spheno-occipital synchondrosis constant evidence of bone resorption on the posterior wall of the pituitary fossa has been observed. Considering this it can be suggested that nasopharyngeal obstruction is alteration of one of the most important function of stomatognathic system and will result in alteration of form of adjoining structures as suggested by **Moss[1]**. This along with alteration of cranial base angle might have resulted in alterationof dimension of Sella turcica in Group II (experimental)of the present study.

The clinical application of the study suggests that alteration in size of Sella turcica might as well result in alteration of most important endocrine gland, Pituitary gland, housing in Sella turcica. Any alteration in Pituitary gland will further affect the hormonal secretions by this gland. Hence, it can be hypothesised that any change or alteration in dimensions of the Sella turcica may affect the height or weight of the subject. There may be a possibility that patients with enlarged adenoids if left untreated may have short stature or ectomorph body type. The studies to find correlation between dimension of Sella turcica to the physical attribute (height and weight) of the patients with any syndromes or pathologies are yet to be done.

CONCLUSION

Following conclusions can be drawn from the present study conducted with aim to evaluate dimensional and morphological changes in Sella turcica secondary to nasopharyngeal obstruction due to enlarged adenoids.

1. There was significant decrease in Sella dimension in subjects with nasopharyngeal obstruction due to enlarged adenoids (Group II) in comparison to subjects with normal sized adenoids (Group I).

2. Highly significant decrease in flexion of cranial base in subjects with enlarged adenoids (Group II) as compared to subjects with normal adenoids (Group I).

3. Significant decrease was seen in nasopharyngeal length in Group II when compared with Group I. Very highly significant increase was seen in adenoid dimension and percentage coverage of nasopharynx in Group II (experimental) when compared with Group I (control).

4. Amongst the morphological shapes of Sella turcica, normal shape of Sella turcica was most common in Group I and pyramidal shape dorsum sellae was most common in Group II.

5. Dimensions of Sella turcica shows positive correlation with cranial base angle. Diameter from dorsum sellae (DS) and diameter from tuberculum sellae (TS) shows significant difference with weak correlation. Average diameter of Sella turcica, average radius of Sella turcica, circumference of Sella turcica and area of Sella turcica shows highly significant difference with weak correlation.

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APPENDIX-I

BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES (FACULTY OF BBD UNIVERSITY), LUCKNOW

INSTITUTIONAL RESEARCH COMMITTEE APPROVAL

The project titled **"Dimensional Changes in Sella Turcica Secondary to Nasopharyngeal Obstruction Due to Enlarged Adenoids: A Cephalometric Study"** submitted by **Dr. Srishti Aditi** Post graduate student from the **Department of Orthodontics & Dentofacial Orthopedics** as part of MDS Curriculum for the academic year 2017-2020 with the accompanying proforma was reviewed by the Institutional Research Committee present on **05th December 2017** at BBDCODS.

The Committee has granted approval on the scientific content of the project. The proposal may now be reviewed by the Institutional Ethics Committee for granting ethical approval.

8/12/17

Prof. (Dr) Vandana A Pant
Co-Chairperson

Prof. (Dr) B. Rajkumar
Chairperson

APPENDIX-II

Babu Banarasi Das University
Babu Banarasi Das College of Dental Sciences,
BBD City, Faizabad Road, Lucknow – 226028 (INDIA)

Dr. Lakshmi Bala
Professor and Head Biochemistry and
Member-Secretary, Institutional Ethics Committee

Communication of the Decision of the VIth Institutional Ethics Sub-Committee

IEC Code: 14 **BBDCODS/01/2018**

Title of the Project: Dimensional Changes in Sella Turcica Secondary to Nasopharyngeal Obstruction Due to Enlarged Adenoids: A Cephalometric Study.

Principal Investigator: Dr. Srishti Aditi **Department:** Orthodontics and Dentofacial Orthopedics

Name and Address of the Institution: BBD College of Dental Sciences Lucknow.

Type of Submission: New, MDS Project Protocol

Dear Dr. Srishti Aditi,

The Institutional Ethics Sub-Committee meeting comprising following four members was held on 30th January 2018.

1.	Dr. Lakshmi Bala Member Secretary	Prof. and Head, Department of Biochemistry, BBDCODS, Lucknow
2.	Dr. Amrit Tandan Member	Prof. & Head, Department of Prosthodontics and Crown & Bridge, BBDCODS, Lucknow
3.	Dr. Rana Pratap Maurya Member	Reader, Department of Orthodontics & Dentofacial Orthopedics, BBDCODS, Lucknow
4.	Dr. Sumalatha M.N. Member	Reader, Department of Oral Medicine & Radiology, BBDCODS, Lucknow

The committee reviewed and discussed your submitted documents of the current MDS Project Protocol in the meeting.
The comments were communicated to PI thereafter it was revised.

Decisions: The committee approved the above protocol from ethics point of view.

Forwarded by:

Lakshmi Bala 05/02/18

(Dr. Lakshmi Bala)
Member-Secretary
IEC

Member-Secretary
Institutional Ethic Committee
BBD College of Dental Sciences
BBD University
Faizabad Road, Lucknow-226028

(Dr. B. Rajkumar)
Principal
BBDCODS

PRINCIPAL
Babu Banarasi Das College of Dental Sciences
(Constituent College of ... University)
BBD City, Faizabad Road, Lucknow-226028

APPENDIX-III

Babu Banarasi Das College of Dental Sciences

(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 226028 (INDIA)

Consent Form (English)

Title of the Study - Dimensional changes in Sella turcica secondary to nasopharyngeal ' obstruction due to enlarged adenoids: A cephalometric study

Study Number……..

Subject's Full Name…….

Date of Birth/Age ……..

Address of the subject ……

Phone no. and e-mail address…….

Qualification ……

Occupation: Student / Self Employed / Service / Housewife/ Other (Please tick as appropriate)

Annual income of the Subject……

Name and of the nominees(s) and his relation to the subject…… (For the purpose of compensation in case of trial related death).

1. I confirm that I have read and understood the Participant Information Document dated……..for the above study and have had the opportunity to ask questions. **OR** I have been explained the nature of the study by the Investigator and had the opportunity to ask questions.
2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason and without my medical care or legal rights being affected.
3. I understand that the sponsor of the project, others working on the Sponsor's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. However, I understand that my Identity will not be revealed in any information released to third parties or published.
4. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s).
5. I permit the use of stored sample (tooth/tissue/blood) for future research.

Yes [ ] No [ ] Not Applicable [ ]

6. I agree to participate in the above study. I have been explained about the complications and side effects, if any, and have fully understood them. I have also read and understood the participant/volunteer's Information document given to me.

Signature (or Thumb impression) of the Subject/Legally Acceptable Representative:……...

Signatory‘s Name……. Date ……..

Signature of the Investigator…… Date……..

Study Investigator‘s Name..... Date……..

Signature of the witness…….. Date……..

Name of the witness……

Received a signed copy of the PID and consent form Signature/thumb impression of the subject or legally acceptable representative Date……..

APPENDIX-IV

Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

सहमति पत्र

अध्ययन शीर्षक..बढे हुए एडेनोइड्स के कारण सांस लेने में होने वाली बाधा के परिणाम हेतु सेल्ला टरसिका में हो रहे आयामी (डायमेंशनल) परिवर्तन का सीफ्लोमेट्रिक अध्ययन ।
अध्ययन संख्या.....
प्रतिभागी के पूर्ण नाम.....
जन्म तिथि / आयु.....
प्रतिभागी का पता .....
फोन नं. और ई-मेल पता .....
योग्यता .....
व्यवसाय: छात्र / स्व कार्यरत / सेवा / ग्रहिणी .....
अन्य (उचित रुप मे टिक करें) .....
प्रतिभागी की वार्षिक आय .....
प्रत्याशीयो के नाम और प्रतिभागी से संबंध...(परीक्षण से संबधित मौत के मामले मे मुआवजे के प्रयोजन के लिए)

1. मेरी पुष्टि है कि मैने अध्ययन हेतु सुचना पत्र दिनांक ..... को पढ व समझ लिया तथा मुझे प्रश्न पुछने या मुझे अध्ययन अन्वेषक ने सभी तथ्यों को समझा दिया है तथा मुझे प्रश्न पुछने के समान अवसर प्रदान किए गये।

2. मैंने यहाँ समझ लिया कि अध्ययन में मेरी भागीदारी पूर्णत: स्वैच्छिक है और किसी भी दबाव के बिना स्वतंत्र इच्छा के साथ दिया है किसी भी समय किसी भी कारण के बिना , मेरे इलाज या कानूनी अधिकारो को प्रभावित किए बिना , अध्ययन में भाग न लेने के लिए स्वतंत्र हुँ ।

3. मैंने यह समझ लिया है कि अध्ययन के प्रायोजक , प्रायोजक की तरफ से काम करने वाले लोग, आचार समिति और नियामक अधिकारियों को मेरे स्वास्थ्य रिकार्ड को वर्तमान अध्ययन या आगे के अध्ययन के सन्दर्भ देखने के लिए मेरी अनुमति की जरूरत नही है, चाहे मैने इस अध्ययन से नाम वापस ले लिया है। हॉलाकि मै यह समझता हुँ कि मेरी पहचान को किसी भी तीसरे पक्ष या प्रकाशित माध्यम में नही दी जायेगी।

4. मै इससे सहमत हूँ कि कोई भी डेटा या परिणाम जो इस अध्ययन से प्राप्त होता है उसका वैज्ञानिक उद्देश्य (ओं) के उपयोग के लिए मेरी तरफ से कोई प्रतिबंध नही है।
5. भविष्य के अनुसंधान के लिए भंडारित नमूना (ऊतक/रक्त) पर अध्ययन के लिए अपनी सहमति देता हुँ।

हॉ [ ] नही [ ] अनउपयुक्त [ ]

6. मै परीक्षण की अनुमति देता हुँ। मुझे इसके द्वारा यदि कोई परेशानी होती है, इसके बारे में जानकारी दे दी गई है। मैने रोगी जानकारी सूचना पत्र को पढ तथा समझ लिया है।

प्रतिभागी / कानूनी तौर पर स्वीकार्य प्रतिनिधि का हस्ताक्षर (या अंगूठे का निशान.....

हस्ताक्षरकर्ता का नाम..... दिनांक .....अन्वेषक के हस्ताक्षर ..... दिनांक .....

अध्ययन अन्वेषक का नाम .....

गवाह के हस्ताक्षर ..... दिनांक .....गवाह के नाम .....

मैनें पीआईडी और विधिवत भरे सहमति फार्म का एक हस्ताक्षर की नकल प्राप्त की.

प्रतिभागी कानूनी तौर पर प्रतिनिधि का हस्ताक्षर/ अंगूठे का निशान ..... दिनांक.....

APPENDIX-V

Babu Banarasi Das College of Dental Sciences
(A constituent institution of Babu Banarasi Das University)

BBD City, Faizabad road, Lucknow – 226028 (INDIA)

Participant Information Document (PID)

1. **Study title**

   Dimensional changes in sella turcica secondary to nasopharyngeal obstruction due to enlarged adenoids : A Cephalometric study

2. **Invitation paragraph**

   You are being invited to take part in a research study. It is therefore important for you to understand why the study is being done and what it will involve. Please take time to read the following information carefully. Ask us for any clarifications or further information. Whether or not you wish to take part is your decision.

3. **What is the purpose of the study?**

   The purpose of this study is to evaluate the dimensional changes in sella turcica and flexion of cranial base secondary to nasopharyngeal obstruction due to enlarged adenoids.

4. **Why have I been chosen?**

   You have been chosen for this study as you are fulfilling the required criteria for this study.

5. **Do I have to take part?**

   Your participation in the research is entirely voluntary. If you do, you will be given this information sheet to keep and will be asked to sign a consent form. During the study you still are free to withdraw at any time and without giving a reason.

6. **What will happen to me if I take part?**
   You will have to undergo radiographic examination for lateral cephalogram before treatment.
7. **What do I have to do?**

   You do not have to change your regular lifestyles for the investigation of the study.

8. What is the procedure that is being tested?

A pre-treatment lateral cephalogram will be taken. Evaluation and comparison of size and shape of sella turcica will be done. The data thus obtained will be subjected for statistical evaluation.

9. What are the interventions for the study?

A pre-treatment lateral cephalogram taken for evaluation and comparison of the size and shape of sella turcica and flexion of head.

10. What are the side effects of taking part?

There are no side effects on patients of this study.

11. What are the possible disadvantages and risks of taking part?

There are no risks or disadvantages of taking part in this study.

12. What are the possible benefits of taking part?

By taking part in this study you are contributing in the medical field and dimenstional changes of sella turcica can be prevented in patients with nasopharyngeal obstruction due to enlarged adenoids.

13. What if new information becomes available?

If additional information becomes available during the course of the research you will be told about these and you are free to discuss it with your researcher, your researcher will tell you whether you want to continue in the study. If you decide to withdraw, your researcher will make arrangements for your withdrawal. If you decide to continue in the study, you may be asked to sign an updated consent form.

14. What happens when the research study stops?

If the study stops/finishes before the stipulated time, this will be explained to the patient/volunteer.

15. What if something goes wrong?

If any severe adverse event occurs, or something goes wrong during the study, the complaints will be handled by reporting to the institution(s), and Institutional ethical committee.

16. Will my taking part in this study be kept confidential?

Yes it will be kept confidential.

17. What will happen to the results of the research study?

Result is the soul properties of the department of the Orthodontics BBDCODS Lucknow. Your identity will be kept confidential in case of any report/publications.

18. Who is organizing the research?

This research study is organized by Department of Orthodontics and Dentofacial Orthopaedics, BBDCODS Lucknow.

19. Will the results of the study be made available after study is over?

Yes.

20. Who has reviewed the study?

The study has been reviewed and approved by the Head of the Department of Orthodontics and Dentofacial Orthopaedics, and the (IEC) (IRC) of the institution.

Contact for further information

Dr. Srishti Aditi
PG student
Department of Orthodontics and
Dentofacial Orthopedics
BabuBanarasi College of Dental
Sciences.
Lucknow-226028
Email id srishtiaditi12@gmail.com
Mob - 8928477842

Dr. Laxmi Bala,
Member Secretary IEC
Babu Banarasi College of
Dental Sciences.
Lucknow

bbdcods.iec@gmail.com

Signature of PI…….
Name……
Date …….

APPENDIX-VI

Babu Banarasi Das College of Dental Sciences

(Babu Banarasi Das University, Lucknow)
BBD City, Faizabad Road, Lucknow – 226028 (INDIA)

प्रतिभागी के लिए सूचना पत्र

1. अध्यन्न ख़िताब

बढे हुए एडेनोइड्स के कारण सांस लेने में होने वाली बाधा के परिणाम हेतु सेल्ला टरसिका में हो रहे आयामी (डायमेंशनल) परिवर्तन का सीफ्लोमेट्रिक अध्ययन I

2. निमंत्रण पैरा

आपको इस शोध में भाग लेने के लिए आमंत्रित किया जा रहा है, इसलिए यह समझना आवश्यक है की यह अध्यन्न क्यों किया जा रहा है और इसमें क्या शामिल होगा I कृपया निम्न जानकारी को सावधानी पूर्वक पढ़ें I किसी भी स्पष्टीकाण के लिए हमें पूछे I आप भाग लेना चाहते है या नहीं आपका निर्णय है I

3. अध्यन्न का उद्देश्य क्या है ?

इस अध्ययन का उद्देश्य बढ़े हुए एडेनोइड्स के कारण सेल्ला टरसिका में आयामी परिवर्तन एवं कपाल बेस के मोड़ में परिवर्तन का आकलन और उनकी तुलना करना है।

4. मैं क्यों चुना गया हूँ ?

आपको इस अध्यन्न के लिए चुना गया है क्यूंकि, आप इस अध्यन्न के लिए आवश्यक मापदंडो को पूरा

5. क्या इसमें मुझे भाग लेना चाहिए?

अनुसंधान के छेत्र में आपकी भागीदारी पूरी तरह स्वैछिक है। यदि आप तैयार है तो आपको इस जानकारी को रखने के लिए पत्र दिया जायेगा और एक सहमित पत्र पर हस्ताक्षर करने के लिए कहा जाएगा। अध्यन्न के दौरान आप कभी भी किसी भी समय और बिना कारण दिए वापस लेने के लिए स्वतंत्र हैं ।

6. क्या होगा यदि मैं इस अध्ययन् में भाग लेता हूँ ?

इलाज के पहले आपको सीफ्लोमेट्रिक रेडियोग्राफ़िक परीक्षा से गुजरना होगा।

7.मुझे क्या करना होगा?

आपको अध्ययन की जांच के लिए अपने नियमित जीवन शैली बदलने की ज़रूरत नही है ।

8. किस प्रक्रिया का परीक्षण किया जा है ?

एक पूर्व उपचार पार्श्व कैफलोग्राम लिया जाएगा। सेल्ला टरसिका के आयामों और पार्श्व कैफलोग्राम पर सिर के फ्लेक्स के ट्रेसिंग, मापन और मूल्यांकन किया जाएगा। इस प्रकार प्राप्त आंकड़ों को सांख्यिकीय मूल्यांकन के लिए लिया जाएगा।

9. इस शोध में कौन से हस्तक्षेप दिए जायेंगे ?

ऑर्थोडॉन्टिक इलाज में सेल्ला टरसिका के आयामी परिवर्तन मापने के लिए इलाज के पहले एक लेटरल सीफ्लोमेट्रिक एक्स-रे लिया जायेगा।

10 इस अध्यन्न में भाग लेने का क्या दुष्प्रभाव है ?

इस अध्यन्न के मरीजो पर कोई दुष्प्रभाव नही होते है ।

11. इस अध्यन्न में भाग लेने के संभावित जोखिम और नुक्सान क्या है?

इस अध्यन्न में भाग लेने में कोई जोखिम या संभावित नुकसान नही है ।

12. भाग लेने के संभावित लाभ क्या है ?

इसमें भाग लेने से आप अनुसंधान छेत्र में अपना सहयोग देंगे जिससे बढे हुए एडेनोइड्स वाले मरीजों का सांस लेने में आने वाली बाधा को शुरू में ही सही कर दिया जाए ताकि सेल्ला टरसिका में आयामी परिवर्तन बचाये जा सकें ।

13. यदि कोई नयी जानकारी उपलब्ध हो जाती है ?

यदि अनुसंधान के दौरान अतिरिक्त जानकारी उपलब्ध हो जाती है तो आपको इनके बारे में बताया जाएगा और आप अपने शोधकर्ता के साथ चर्चा करने के लिए स्वतंत्र हैं, आपका शोधकर्ता आपको बताएगा कि क्या आप अध्ययन में जारी रखना चाहते हैं। यदि आप तय करते हैं तो वापस लेने, आपका शोधकर्ता आपके वापसी के लिए व्यवस्था करेगा अगर तुम अध्ययन में जारी रखने का निर्णय लेते हैं, तो आपको एक अद्यतन सहमति फॉर्म पर हस्ताक्षर करने के लिए कहा जा सकता है।

14. जब शोध अध्यन्न बंद हो जाता है तो क्या होता है?

अध्यन्न बंद हो जाता है या निर्धारित समय से पहले ख़त्म हो जाता है तब मरीज / स्वयंसेवक को समझाया जाएगा ।

15. क्या कुछ गलत हो सकता है?

यदि कोई गंभीर प्रतिकूल घटना होती है, या अध्ययन के दौरान कुछ गलत हो जाता है, तो शिकायतों को संस्था (संस्थाओं), और संस्थागत नैतिक समिति को रिपोर्ट करके संभाला जाएगा।

16. इस अध्ययन में मेरे हिस्से को गोपनीय रखा जाएगा?

हाँ, यह गोपनीय रखा जाएगा।

17. शोध अध्ययन के परिणामों का क्या होगा?

परिणाम ऑर्थोडान्टिक्स और डेंटोफेसियल ऑर्थोपेडिक्स दन्त चिकित्सा विज्ञानं के बाबू बनारसी दास कॉलेज लखनऊ के विभाग की आत्मा गुण है लखनऊ। किसी भी रिपोर्ट / प्रकाशन के मामले में आपकी पहचान को गोपनीय रखा जाएगा।

18. जो अनुसंधान का आयोजन किया जाता है?

यह शोध अध्ययन ऑर्थोडेंटिक्स और डेंटोफेसियल विभाग दन्त चिकित्सा विज्ञानं के बाबू बनारसी दास कॉलेज लखनऊ द्वारा आयोजित किया जाता है।

19. क्या अध्ययन ख़त्म हो जाने बाद अध्ययन के परिणामों को उपलब्ध कराया जाएगा ?

हाँ।

20. कौन अध्ययन की समीक्षा किया है?

अध्ययन की समीक्षा की गई है और ऑर्थोडान्टिक्स और डेंटोफेसियल ऑर्थोपेडिक्स विभाग के प्रमुख ने मंजूरी दे दी है, संस्था की आईईसी और आईआरसी ।

21.अधिक जानकारी के लिए संपर्क

डॉ. सृष्टि अदिति
पीजी छात्र
ऑर्थोडान्टिक्स और डेंटोफेसियल ऑर्थोपेडिक्स विभाग
बाबू बनारसी दास कॉलेज ऑफ़ डेंटल साइंस
लखनऊ-226028
Email id srishtiaditi12@gmail.com
Mob- 8928477842

डॉ लक्ष्मी बाला,
सदस्य सचिव आईईसी
बाबू बनारसी दास कॉलेज ऑफ़ डेंटल साइंसेज
लखनऊ- 226028
bbdcods.iec@gmail.com

पीआई के हस्ताक्षर .....।
नाम .....
तारीख__

APPENDIX-VII

Babu Banarasi Das College of Dental Sciences
(A constituent institution of Babu Banarasi Das University)

BBD City, Faizabad road, Lucknow – 226028 (INDIA)

Child Information Document

Study title: — Dimensional changes in Sella Turcica secondary to nasopharyngeal obstruction due to enlarged adenoids: A cephalometric study.

Introduction

Describe briefly the purpose of this study We invite you to participate in this study.

What will you have to do?

To participate in this research study, you will be interviewed/ examined by……

……..and if found to fulfill pre-specified criteria, you will be eligible to be enrolled in this research study.

Since you are in the age group of 8-18 years we ask your accompanying parent / guardian will also sign a similar form called as the Parent Informed Consent Form.

List all procedures, which will be employed in the study. Point out any that are considered experimental/or otherwise, and explain technical and medical terminology in simple, nontechnical & direct language.

In addition, to record the same parameters daily your parent / guardian will also be provided with a diary where they will enter the same findings accordingly. You will have to tell them about your symptom and they will mark accordingly in the diary

Risks and discomforts

There is no foreseen significant risk / hazard to your health, if you wish to participate in the study. If you follow the directions of the …….. in charge of this study and you are injured due to any procedure given under the study plan, the Sponsor will pay for the medical expenses for the treatment of that injury.

Benefits

If you participate in the study you will receive ……If you appear to have any acute illness ……you will be offered free treatment for those visits in accordance with local standard medical care. You will not be offered free treatment for chronic diseases or conditions

not related to study procedures.

Your participation in the study may help others, because this participation will help us determine if the study drug/procedure is safe.

Confidentiality

Your existing medical records may be accessed; personal health information about you may be collected and processed by study investigators for the purpose of performing the study. Information about you will be collected and stored in files with an assigned number, and not directly with your name. All documents related to the study will only be accessed by the study investigator, sponsor, the Ethics Committee and the Regulatory authority.

Your parent / guardian will have the right to access personal information about you at any time with the study doctor and the right to correct this personal information. Your parent / guardian can take away your authorization to collect process and disclose data about you at any time.

Right to refuse or withdraw

You do not have to take part in this research if you do not wish to do so. You may stop participating in the research at any time you wish. The study investigator may decide to withdraw you from the study if he/she considers it is in your best interest

You will be informed of important new findings developed during the course of the study so you will be able to consider your participation in the study in light of new information.

Parents responsibilities'

It is the responsibility of your parent / guardian to come along with you to the centre during the study period for all the visits unless you withdraw or are prematurely discontinued from the study. It is also your responsibility and your parent / guardian to report any expected or unexpected reactions (side effects) that you notice during the study period.

We expect your co-operation throughout the study.

APPENDIX-VIII

Banarasi Das College of Dental Sciences

(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 226028 (INDIA) ,

बाल सूचना दस्तावेज़

अध्ययन शीर्षक:- बढे हुए एडेनोइड्स के कारण सांस लेने में होने वाली बाधा के परिणाम हेतु सेल्ला टरसिका में हो रहे आयामी (डायमेंशनल) परिवर्तन का सीफ्लोमेट्रिक अध्ययन |

परिचय

आपको इस शोध में भाग लेने के लिए आमंत्रित किया जा रहा है। इस अध्ययन का उद्देश्य बढ़े हुए एडेनोइड्स के कारण सेल्ला टरसिका में आयामी परिवर्तन एवं कपाल बेस के मोड़ में परिवर्तन का आकलन और उनकी तुलना करना है।

आपको क्या करना होगा।

इलाज के पहले आपको सीफ्लोमेट्रिक रेडियोग्राफ़िक परीक्षा से गुजरना होगा। आपको अध्ययन की जांच के लिए अपने नियमित जीवन शैली बदलने की ज़रूरत नही है । आप 8 से 18 साल के आयु वर्ग के हैं, इसलिए हम आपके माता-पिता / अभिभावक से पूछते हैं कि वो सूचना पत्र पर हस्ताक्षर करेंगे।

जोखिम और असुविधाएँ

इस अध्यन्न के मरीजो पर कोई दुष्प्रभाव नही होते है । इस अध्यन्न में भाग लेने में कोई जोखिम या संभावित नुकसान नही है । यदि कोई गंभीर प्रतिकूल घटना होती है, या अध्ययन के दौरान कुछ गलत हो जाता है, तो शिकायतों को संस्था (संस्थाओं), और संस्थागत नैतिक समिति को रिपोर्ट करके संभाला जाएगा।

लाभ

इसमें भाग लेने से आप अनुसंधान छेत्र में अपना सहयोग देंगे जिससे बढे हुए एडेनोइड्स वाले मरीजों का सांस लेने में आने वाली बाधा को शुरू में ही सही कर दिया जाए ताकि सेल्ला टरसिका में आयामी परिवर्तन बचाये जा सकें ।

गोपनीयता

आपके मौजूदा मेडिकल रिकॉर्ड तक पहुंचा जा सकता है; अध्ययन करने के उद्देश्य के लिए आपके व्यक्तिगत स्वास्थ्य सूचना, अध्ययन जांचकर्ताओं द्वारा एकत्रित और संसाधित की जा सकती है। आपके बारे में जानकारी एक तय संख्या के साथ फाइल में एकत्रित और संग्रहीत की जाएगी, और सीधे आपके नाम से नहीं। अध्ययन से

संबंधित सभी दस्तावेज केवल अध्ययन शोधकर्ता, प्रायोजक, नीतिशास्त्र समिति और नियामक प्राधिकरण द्वारा ही उपयोग किए जा सकते हैं।

आपके माता-पिता / अभिभावक को अध्ययन शोधकर्ता के साथ किसी भी समय व्यक्तिगत जानकारी मे अभिगम करने का अधिकार होगा और इस व्यक्तिगत जानकारी को ठीक करने का अधिकार होगा। आपके माता-पिता / अभिभावक प्रक्रिया को इकट्ठा करने और किसी भी समय आपके बारे में डेटा का खुलासा करने के लिए अपना प्राधिकरण निकाल सकते हैं।

मना या वापस लेने का अधिकार

यदि आप ऐसा नहीं करना चाहते हैं तो आपको इस शोध में भाग लेने की आवश्यकता नहीं है। आप किसी भी समय अपनी इच्छानुसार शोध में भाग लेने से रोक सकते हैं। अध्ययन शोधकर्ता अध्ययन से आपको वापस लेने का फैसला कर सकता है यदि वह समझता है कि वह आपके सर्वोत्तम हित में है।

आपको अध्ययन के दौरान विकसित महत्वपूर्ण नई जानकारी के बारे में सूचित किया जाएगा ताकि आप नई जानकारी के प्रकाश में अध्ययन में अपनी भागीदारी पर विचार कर सकें।

माता-पिता की ज़िम्मेदारियाँ

जब तक यह अध्ययन आपकी सहमति से जारी रहेगा, सभी विजिटों पर आपको केंद्र पर लाने की ज़िम्मेदारी आपके माता-पिता / अभिभावक की है। अध्ययन के दौरान किसी भी अपेक्षित या अप्रत्याशित प्रतिक्रिया (साइड इफेक्ट) की जानकारी देना आपकी या आपके माता-पिता / अभिभावक की ज़िम्मेदारी होगी।

हम पूरे अध्ययन के दौरान आपके सहयोग की उम्मीद करते हैं।

APPENDIX-IX

Babu Banarasi Das College of Dental Sciences

(Babu Banarasi Das University, Lucknow)
BBD City, Faizabad Road, Lucknow – 226028 (INDIA)

Child Assent Form

Study Title: Dimensional changes in Sella turcica secondary to nasopharyngeal obstruction due to enlarged adenoids: A cephalometric study.

Study Number:_____

Subject's Full Name:_____

Date of Birth/Age:_____

Address:_____

I_____, exercising my free power of choice, hereby give my consent for participation in the study entitled: "Dimensional changes in Sella turcica secondary to nasopharyngeal obstruction due to enlarged adenoids: A cephalometric study." I have been informed, to my satisfaction, by the attending physician, about the purpose of the study and the nature of the procedure to be done. I am aware that my parents/guardians do not have to bear the expenses of the treatment if I suffer from any trial related injury, which has causal relationship with the said trial drug. I am also aware of right to opt out of the trial, at any time during the course of the trial, without having to give reasons for doing so ,

Signature of the study participant_____Date:_____
Name of the study participant_____

Signature of the Witness_____Date:_____
Name of the Witness _____

Signature of the attending Physician_____Date:_____
Name of the attending Physician_____

APPENDIX-X

Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 226028 (INDIA)

शिशु सहमति पत्र

मैं _____में भाग लेने के लिए अपनी सहमति प्रदान करता हूँ | मुझे इस अध्ययन के हेतु और उसमे की जाने वाली प्रक्रिया के बारे में चिकिस्तक द्वारा बता दिया गया है| मुझे पता है कि अध्ययन सम्बन्धी किसी हानि जिसका अध्ययन की दावा से सम्बन्ध है उसका खर्च मेरे माता पिता अथवा अभिवाहक को नहीं वहां करना है | मुझे यह भी पता है कि मैं इस अध्ययन से किसी समय बिना कोई कारण बताये बाहर हो सकता हूँ |

अध्ययन में भाग लेने वाले का नाम और हस्ताक्षर
_____दिनांक_____

गवाह के हस्ताक्षर _____दिनांक _____

गवाह का नाम _____

चिकिस्तक का नाम और हस्ताक्षर_____दिनांक_____

APPENDIX-XI

Formula used for statistical analysis

STATISTICAL TOOLS EMPLOYED

Data was entered into Microsoft Excel spreadsheet and was checked for any discrepancies. Summarized data was presented using Tables and Graphs. The data was analysed by SPSS (version 21.0). Shapiro Wilk test was used to check which all variables were following normal distribution. Data was found to be normally distributed (p-value was more than 0.05). Therefore, bivariate analyses were performed using the parametric tests *i.e.,* Independent test (for comparing two groups). Level of statistical significance was set at p-value less than 0.05.

The following Statistical formulas were used:

A. The Arithmetic Mean

The most widely used measure of central tendency is arithmetic mean, usually referred to simply as the mean, calculated as

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n},$$

B. The Standard Deviation

The standard deviation (SD) is the positive square root of the variance, and calculated as

$$SD = \sqrt{\frac{\sum X_i^2 - \frac{(\sum X_i)^2}{n}}{n-1}}$$

where, n= no. of observations

and also denoted by subtracting minimum value from maximum value as below

C. Tests of significance

Test of significance are used to estimate the probability that the relationship observed in the data occurred purely by chance was there a relationship between the variables. They are used to test the hypothesis proposed at the start of the study.

In this study Parametric tests were used

a) **The data was normally distributed**
b) **The data was obtained from the sample which is randomly selected**
c) **The data was quantitative data**

t – TEST

1. t tests are based on the t distribution which is a symmetrical, bell-shaped curve like the normal distribution, but having different area and probability properties.

t distribution is a family of curves which are differentiated by their degrees of freedom.

With increasing sample sizes, the t distribution assumes the shape of the normal distribution. 2. A sample size of 100 is often chosen as the cut-off point for deciding when to apply For t or z.

TYPES OF t TESTS INDICATIONS.

Independent t test (equal variance assumed)

The unpaired t test is used for comparing two independent groups of observations when no suitable pairing of the observations is possible. The samples do not need to be of equal sizes.

Assumptions. The test requires the populations to be normally distributed with equal variance, though the test is relatively robust to deviations from these assumptions. Unpaired t test or two-sample t test (unequal variance)

When the variances of the two groups differ and transformation does not produce equal variance, the calculation of the t test becomes more complex. Instead of using the pooled variance, estimates of the individual population variances are used

Formula: ,

$$t = \frac{M_x - M_y}{\sqrt{\frac{S_x^2}{n_x} + \frac{S_y^2}{n_y}}}$$

M =mean

n = number of scores per group

$$S^2 = \frac{\sum (x - M)^2}{n - 1}$$

x =individual scores

M =mean

n= number of scores in group

- Define the problem
- State null hypthesis(H_0) & alternate hypothesis(H_1)
- Find t value, Find (X_1 - X_2)
- Calculate SE of difference between two means

SE = $\sigma\sqrt{1/n_1+1/n_2}$ or

t = (X_1 - X_2) / SE ,

- Calculate degree of freedom = n_1 + n_2 - 2
- Fix the level of significance (0.05)
- Compare calculated value with table value at corresponding degrees of freedom and significance level
- If observed t value is greater than theoretical t value, t is significant, reject null hypothesis and accept alternate hypothesis.

CHI-SQUARED TEST

- It is to determine if there is any association between categorical data from two or more groups.

- Categorical data are data that can be separated into distinct groups that do not have a numerical relationship or order between them.

Methodology. ,

(a) Make a contingency table. Data are organized into a contingency table comprising row, and columns. The categories for one variable define the rows, and the categories for the other variable defines column.

(b) Test the difference between observed and expected values.

1. Test compares the size of the discrepancy between the numbers observed in the rows and columns against the number that would be expected if the null hypothesis (that there are no differences between the groups) was true.
2. If the observed and expected values are close then it would be reasonable to anticipate that the null hypothesis is true. 2
3. Chi square distribution is a family of probability density curves that are defined by the number of degrees of freedom.
4. The test statistic CHI square is a squared value it will, always be positive and greater than zero irrespective of the direction of the difference between samples (i.e. greater than or less than).
5. Right hand tail of the CHI square distribution therefore represents the two-tailed probability that the samples were derived from the same population. 2 CHI square tests are therefore always regarded as two sided.

Assumptions.

1. Sample is randomly selected from the population.

2. Actual frequencies (not percentages or proportions) are entered into the contingency table.

3. Observations should be independent (not paired) if data are paired, McNemar's test should be used.

4. All values must be greater than 1. 5. 80% of the expected values must be >5.

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

,

O : OBSERVED FREQUENCY

E : EXPECTED FREQUENCY

Level of significance: "p" is level of significance

p > 0.05	Not significant
p <0.05	Significant
p <0.01	Highly significant
p <0.001	Very highly significant

A correlation coefficient of 1 means that for every positive increase in one variable, there is a positive increase of a fixed proportion in the other. A correlation coefficient of -1 means that for every positive increase in one variable, there is a negative decrease of a fixed proportion in the other. Zero means that for every increase, there isn't a positive or negative increase. The two just aren't related

,

correlation coefficient is a statistical measure of the strength of a monotonic relationship between paired data.

- .00-.19 "very weak"
- .20-.39 "weak"
- .40-.59 "moderate"
- .60-.79 "strong"
- .80-1.0 "very strong"

MASTER CHART

Experimental group

S.No.	SAMPLE	DS	TS	AVERAGE DIAMETER	AVERAGE RADIUS	CIRCUMFERENCE	AREA	CRANIAL BASE ANGLE	NORMAL NASO-PHARYNGEAL LENGTH	ADENOID LENGTH	PERCENTAGE OF OBSTRUCTION
1	Abhi	2.46	3.75	3.11	1.55	9.75	7.57	132.32	13.52	6.30	46.60%
2	Anurag	2.86	3.37	3.12	1.56	9.79	7.62	130.80	9.58	5.71	59.60%
3	Ashutosh	2.54	3.55	3.05	1.52	9.57	7.28	130.52	11.06	6.35	57.41%
4	Aumsi	3.69	4.38	4.04	2.02	12.68	12.79	132.74	11.60	6.79	58.53%
5	Kavita	3.07	3.86	3.47	1.73	10.89	9.43	128.40	11.02	5.20	47.19%
6	Mohd. Faiz	2.98	4.34	3.66	1.83	11.50	10.52	137.04	10.74	5.94	55.31%
7	Parvesh	2.51	4.35	3.43	1.72	10.78	9.24	127.97	11.54	5.03	43.59%
8	Payal	3.14	3.73	3.44	1.72	10.79	9.27	133.23	11.45	5.92	51.70%
9	Richa	2.83	3.93	3.38	1.69	10.62	8.97	125.28	9.47	4.80	50.69%
10	Vivek Kr	3.00	3.14	3.07	1.54	9.64	7.40	124.08	11.78	6.54	55.52%
11	Samar S	2.11	2.98	2.55	1.27	8.00	5.09	135.05	11.68	7.34	62.84%
12	Ujjwal	2.98	3.43	3.21	1.60	10.07	8.07	123.32	10.32	5.66	54.84%
13	Adarsh J	3.00	3.00	3.00	1.50	9.42	7.07	129.03	11.62	6.18	53.18%
14	Aditi Dw	3.13	3.27	3.20	1.60	10.05	8.04	135.36	11.94	7.03	58.88%
15	Akhilesh	3.31	2.38	2.85	1.42	8.94	6.36	119.56	14.03	6.80	48.47%
16	Anshika 1	2.27	3.18	2.73	1.36	8.56	5.83	127.04	9.34	4.59	49.14%
17	Anshika 2	2.59	3.33	2.96	1.48	9.30	6.88	125.39	10.16	4.39	43.21%
18	Anushka D	2.61	3.71	3.16	1.58	9.93	7.84	129.07	11.12	5.61	50.45%
19	Aryan	1.97	3.13	2.55	1.28	8.01	5.11	127.89	10.49	6.25	59.58%
20	Komal	2.16	2.96	2.56	1.28	8.04	5.15	136.81	11.26	5.69	50.53%
21	Lavi	2.51	3.63	3.07	1.54	9.64	7.40	133.90	11.75	5.72	48.68%
22	Nivedita G	2.75	3.64	3.20	1.60	10.04	8.02	125.90	9.87	6.27	63.53%
23	Parth	2.03	3.02	2.53	1.26	7.93	5.01	134.92	10.94	5.76	52.65%
24	Prachi 1	4.11	4.08	4.10	2.05	12.86	13.17	138.96	10.92	5.43	49.73%
25	Prakhar P	2.23	3.00	2.62	1.31	8.22	5.37	123.84	11.03	5.07	45.97%
26	Pratyush	3.46	4.22	3.84	1.92	12.06	11.58	127.98	12.48	5.90	47.28%
27	Raj Pandey	2.05	3.05	2.55	1.28	8.01	5.11	135.15	11.89	6.35	53.41%
28	Shreyan	2.56	2.93	2.75	1.37	8.62	5.92	134.74	12.18	8.06	66.17%
29	Sneha	3.66	3.45	3.56	1.78	11.17	9.93	130.71	9.47	5.34	56.39%
30	Vimal	2.35	2.23	2.29	1.15	7.19	4.12	136.81	11.04	6.21	56.25%
31	S1	1.93	3.43	2.68	1.34	8.42	5.64	123.26	11.49	6.92	60.23%
32	S2	2.22	2.45	2.34	1.17	7.34	4.28	124.36	11.50	6.89	59.91%
33	S3	2.59	2.55	2.57	1.29	8.07	5.19	126.54	10.53	4.84	45.96%
34	S4	2.38	2.62	2.50	1.25	7.85	4.91	124.54	10.33	5.31	51.40%
35	S5	2.94	2.59	2.77	1.38	8.69	6.00	129.98	10.69	5.89	55.10%
36	S6	2.08	2.96	2.52	1.26	7.92	4.99	130.52	11.93	7.08	59.35%
37	S7	2.59	3.86	3.23	1.61	10.13	8.17	125.41	10.04	5.48	54.58%
38	S8	2.43	3.54	2.99	1.49	9.38	7.00	128.79	13.20	7.84	59.39%
39	S9	1.99	3.56	2.78	1.39	8.72	6.05	129.52	10.52	6.23	59.22%
40	S10	2.18	3.16	2.67	1.34	8.39	5.60	126.08	11.92	6.02	50.50%
41	S11	2.46	3.38	2.92	1.46	9.17	6.70	126.86	11.53	5.88	51.00%
42	S12	1.97	3.36	2.67	1.33	8.37	5.58	127.09	10.79	6.45	59.78%
43	S13	2.19	3.45	2.82	1.41	8.86	6.25	129.01	11.53	7.20	62.45%
44	S14	3.46	3.43	3.45	1.72	10.82	9.32	130.06	11.44	6.88	60.14%
45	S15	2.63	3.70	3.17	1.58	9.94	7.87	122.03	12.22	6.80	55.65%
46	S16	2.32	2.99	2.66	1.33	8.34	5.54	124.33	11.56	7.30	63.15%
47	S17	4.13	4.53	4.33	2.17	13.60	14.73	131.86	12.42	6.03	48.55%

48	S18	2.74	3.56	3.15	1.58	9.90	7.79	135.22	12.54	6.37	50.80%
49	S19	2.20	3.28	2.74	1.37	8.61	5.90	123.45	10.46	6.56	62.72%
50	S20	1.98	3.21	2.60	1.30	8.15	5.29	125.55	11.89	7.65	64.34%
MEAN		**2.65**	**3.37**	**3.01**	**1.50**	**9.45**	**7.11**	**129.17**	**11.28**	**6.16**	**54.63%**
Nos		**50.00**	**50.00**	**50.00**	**50.00**	**50.00**	**50.00**	**50.00**	**50.00**	**50.00**	**50.00**

Control group

S.No.	SAMPLE	DS	TS	AVERAGE DIAMETER	AVERAGE RADIUS	CIRCUMFERENCE	AREA	CRANIAL BASE ANGLE	NORMAL NASO-PHARYNGEAL LENGTH	ADENOID LENGTH	PERCENTAGE OF OBSTRUCTION
1	Abhay	3.05	3.49	3.27	1.64	10.27	8.40	131.56	11.53	2.29	19.86%
2	Abhishek	2.43	3.69	3.06	1.53	9.61	7.35	135.83	11.6	3.08	26.55%
3	Anjali Y	3.04	3.25	3.15	1.57	9.88	7.77	133.86	12.02	2.34	19.47%
4	Anjali J	2.46	3.98	3.22	1.61	10.12	8.14	128.21	12.34	2.92	23.66%
5	Anushka D	2.27	3.68	2.98	1.49	9.35	6.95	133.66	12.08	2.16	17.88%
6	Avarnika	2.61	3.04	2.83	1.41	8.87	6.27	125.92	11.45	2.76	24.10%
7	Avantika	3.41	4.26	3.84	1.92	12.05	11.55	136.68	11.49	2.53	22.02%
8	Chhaya	2.84	4.3	3.57	1.79	11.22	10.01	131.06	11.06	1.5	13.56%
9	Isha	1.91	3.61	2.76	1.38	8.67	5.98	133.67	10.89	1.73	15.89%
10	Himanshu	2.82	3.35	3.09	1.54	9.69	7.47	131.53	11.3	2.37	20.97%
11	Isha A	2.51	3.86	3.19	1.59	10.01	7.97	132.55	10.53	1.58	15.00%
12	Janvi	2.69	3.81	3.25	1.63	10.21	8.30	121.84	11.29	2.19	19.40%
13	Khushboo	2.88	3.48	3.18	1.59	9.99	7.94	125	10.54	2.35	22.30%
14	Kirti G	3.1	3.71	3.41	1.70	10.70	9.11	122.37	10.36	3.85	37.16%
15	Pavani K.	2.16	3.6	2.88	1.44	9.05	6.51	134	10.36	2.47	23.84%
16	Pratibha M	2.52	3.37	2.95	1.47	9.25	6.81	129.68	13.34	4.32	32.38%
17	Riyanshu	3.85	4.12	3.99	1.99	12.52	12.47	132.65	11.55	3.03	26.23%
18	Ruchi	4.2	3.79	4.00	2.00	12.55	12.53	133.76	12.2	3.56	29.18%
19	Rushil	3.28	3.9	3.59	1.80	11.28	10.12	134.22	11.96	2.98	24.92%
20	Sahib ali	2.49	3.28	2.89	1.44	9.06	6.54	140.68	11.09	2.94	26.51%
21	Seeba	3.12	3.37	3.25	1.62	10.19	8.27	136.34	11.75	2.18	18.55%
22	Shivani	3.07	4.09	3.58	1.79	11.25	10.07	137.69	11.53	3.38	29.31%
23	Shivaji	2.5	2.8	2.65	1.33	8.33	5.52	129.71	11.12	3.01	27.07%
24	Shruti S	2.52	3.27	2.90	1.45	9.09	6.58	131.5	12.54	3.89	31.02%
25	Vineeta	2.74	3.72	3.23	1.62	10.15	8.19	134.68	12.57	5.46	43.44%
26	Vishakha	2.94	3.65	3.30	1.65	10.35	8.53	130.58	10.39	3.96	38.11%
27	Aditi Sahu	3.25	4.6	3.93	1.96	12.33	12.10	135.25	11.45	3.18	27.77%
28	Aditi Shu	4.3	4.4	4.35	2.18	13.67	14.86	133.62	11.86	3.52	29.68%
29	Archita P	3.65	3.89	3.77	1.89	11.84	11.16	130.56	10.56	2.99	28.31%
30	Atharva P	4.02	3.99	4.01	2.00	12.58	12.60	131.88	12.35	4.11	33.28%
31	Ishika M	3.76	4.03	3.90	1.95	12.24	11.92	133.46	11.75	3.12	26.55%
32	Ketan G	2.43	2.36	2.40	1.20	7.52	4.51	130.55	14.24	5.1	35.81%
33	Luv Kush	2.88	3.69	3.29	1.64	10.32	8.48	132.7	12.81	5.98	46.68%
34	Lokesh M	4.39	4.32	4.36	2.18	13.68	14.90	135.31	14.32	5.38	37.57%
35	Manshi	2.98	3.36	3.17	1.59	9.96	7.89	134.89	11.91	4.61	38.71%
36	Muskaan	2.64	4.15	3.40	1.70	10.67	9.05	118.64	9.98	3.3	33.07%
37	Prachi 2	3.28	3.36	3.32	1.66	10.43	8.66	134.01	10.8	3.02	27.96%
38	Parabdh	2.88	4.31	3.60	1.80	11.29	10.15	126.16	11.41	4.5	39.44%
39	Priyanka	3.34	4.02	3.68	1.84	11.56	10.64	130.44	10.69	3.93	36.76%
40	Radhika	3.64	6.33	4.99	2.49	15.66	19.52	134.32	11.04	3.97	35.96%
41	Raja	2.71	3.02	2.87	1.43	9.00	6.45	124.22	11.7	4.1	35.04%
42	Rawaan	2.65	3.84	3.25	1.62	10.19	8.27	125.69	13.2	5.68	43.03%
43	Rosy	2.53	3.03	2.78	1.39	8.73	6.07	131.38	12.36	3.87	31.31%
44	Ruby	2.51	2.42	2.47	1.23	7.74	4.77	128.8	13.35	3.72	27.87%
45	Sanoj	2.71	2.69	2.70	1.35	8.48	5.73	127.3	13.96	4.07	29.15%

46	Shashank	2.81	2.83	2.82	1.41	8.86	6.25	131.47	12.15	5.34	43.95%
47	Shivam	2.92	3.32	3.12	1.56	9.80	7.65	133.81	11.56	2.98	25.78%
48	Swarnim	2.27	3.4	2.84	1.42	8.91	6.31	134.29	12.41	5.37	43.27%
49	Tanu V	2.79	3.33	3.06	1.53	9.61	7.35	137.9	11.85	4.25	35.86%
50	Yuvraj	2.24	3.5	2.87	1.44	9.02	6.47	131.43	11.12	3.98	35.79%
MEAN		**2.94**	**3.65**	**3.30**	**1.65**	**10.36**	**8.53**	**131.55**	**11.75**	**3.50**	**29.54%**
Nos		**50.00**	**50.00**	**50.00**	**50.00**	**50.00**	**50.00**	**50.00**	**50.00**	**50.00**	**50.00**

Morphology of Sella turcica

S.No.	Shape of Sella Turcica	Group I (Normal adenoids)	Group II (Enlarged adenoids)	P value	Significance
1.	Normal Sella Turcica **(A)**	19 38.0%	8 16.0%	0.012*	S
2.	Oblique anterior wall **(B)**	5 10.0%	3 6.0%	0.357	NS
3.	Double contour of the floor **(C)**	11 22.0%	12 24.0%	0.500	NS
4.	Sella Turcica bridge **(D)**	0 0.00%	0 0.00%	NA	NA
5.	Irregularity (notching) in the posterior part of the Sella Turcica **(E)**	11 22.0%	9 18.0%	0.402	NS
6.	Pyramidal Shape dorsum sellae **(F)**	2 4.0%	18 36.0%	<0.0001***	VHS

Urkund Analysis Result

Analysed Document:	plagiarism.docx (D59725883)
Submitted:	27/11/2019 09:57:00
Submitted By:	dramitn99@bbdu.ac.in
Significance:	8 %

Sources included in the report:

RADIOMORPHOMETRIC ANALYSIS OF SELLA TURCICA IN ADULT SOUTH INDIAN POPULATION - Copy for Pliagrism.docx (D57009139)
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SUMMARY

Nasopharyngeal area is an important part of oro-facial capsule, and soft tissue of this region may have an important bearing on growth of adjoining skeletal structures. It was believed and expressed, that obstruction due to adenoids might influence the developing facial conformity. Normally, the nasopharynx enlarges to accommodate the growing adenoids, thus maintaining a patent nasopharyngeal airway. Any imbalance in this may result in reduced patency and nasopharyngeal obstruction which might influence the form of adjoining skeletal structures. At times this is compensated by the variations in natural head position, ranging between extension and flexion due to altered respiratory pathway.[3]

Extension of the head for the shift from nasal to mouth breathing results in anterior and ascending displacement of the occipital condyles on the superior articular surfaces of the first vertebrae, Atlas. This causes the horizontal line of sight of the orbits to be angled upward, with resultant shift of the visual field, needed for postural compensation. Hence extension of the head in relation to the cervical vertebral column was correlated with a larger cranial base angle which can be further correlated with the one of the important land-mark in Orthodontics, Sella turcica. The Alteration in size of the Sella turcica had been seen in pituitary pathologies. The morphology of the Sella was described subjectively and qualitatively, and alterations were categorized into different types such as circular, oval, flat, shallow and J-shaped. Becktor et al. (2000)[6] and Jones et al. (2005)[7] found increased frequency of a Sella turcica bridge in patients with severe craniofacial deviations. However, literature is not available to establish relation between dimension of Sella turcica and nasopharyngeal obstruction. The role of enlarged adenoids in altered dentofacial morphology is well established but till date no studies have been conducted to correlate dimensional changes in Sella turcica due to enlargement of adenoids. Therefore, it was decided to evaluate the dimensional and morphological changes of Sella turcica and alteration in cranial base angle secondary to nasopharyngeal obstruction due to enlarged adenoids.

This cephalometric study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow to evaluate the dimensional changes in Sella turcica and flexion of cranial base

secondary to nasopharyngeal obstruction due to enlarged adenoids and to find correlation between dimensional changes in Sella turcica with flexion angle of cranial base. Sample for the present study comprised of 100 lateral cephalograms of pre-treated patients with age ranging from 9 to 15 years which are equally distributed amongst the 2 groups with 50 sample in each group. The sample was selected and divided into 2 groups after assessment of percentage coverage of nasopharynx (adenoid length/nasopharyngeal space). For its assessment the exact center of Sella turcica (Sc) has to be determined. It is done by making the two circles touching maximum surface of interior of the posterior and anterior wall. The centres of these two circles are joined together and the centre of this line is considered as centre of the Sella turcica named as Sc. This method of measuring centre of a circular or elliptical body is also used by Khanna et al. (2011)[13] in their study. The advantage of this method is that it is efficient in calculating the dimensions of Sella turcica rather than arbitrarily marking the centre of Sella turcica. Considering Sella as an elliptical/oval body – diameter, circumference and area of Sella turcica is measured. A more reliable and new method to measure the dimension as well as to mark the centre of Sella turcica can be obtained through this study.

The group I represents the patients with normal adenoids with percentage coverage of nasopharynx of less than 45 while the Group II represents the patients with enlarged adenoids having percentage coverage of nasopharynx equal to or more than 45.

A total of ten parameters were considered in the present study with six parameters evaluating dimensions of Sella turcica (diameter from dorsum sellae, diameter from tuberculum sellae, average diameter, average radius, circumference, area), three parameters evaluating dimensions of nasopharyngeal space (nasopharyngeal space, adenoid dimension, percentage coverage of nasopharynx) and one parameter for evaluating cranial base angle (Graph 2, 3, 4). Also, morphology of Sella turcica was determined. Data obtained for both the groups was subjected to appropriate statistical analysis.

Following conclusion can be drawn from the present study conducted to evaluate dimensional changes in Sella turcica secondary to nasopharyngeal due to enlarged adenoids.

1. There was significant decrease in Sella dimension in subjects with nasopharyngeal obstruction due to enlarged adenoids (Group II) in comparison to subjects with normal sized adenoids (Group I).

2. Highly significant decrease in flexion of cranial base in subjects with enlarged adenoids (Group II) as compared to subjects with normal adenoids (Group I).

3. Significant decrease was seen in nasopharyngeal length in Group II when compared with Group I. Very highly significant increase was seen in adenoid dimension and percentage coverage of nasopharynx in Group II (experimental) when compared with Group I (control).

4. Amongst the morphological shapes of Sella turcica, normal shape of Sella turcica was most common in Group I and pyramidal shape dorsum sellae was most common in Group II.

5. Dimensions of Sella turcica shows positive correlation with cranial base angle. Diameter from dorsum sellae (DS) and diameter from tuberculum sellae (TS) shows significant difference with weak correlation. Average diameter of Sella turcica, average radius of Sella turcica, circumference of Sella turcica and area of Sella turcica shows highly significant difference with weak correlation.

The clinical application of the study suggests that alteration in size of Sella turcica might as well result in alteration of most important endocrine gland, Pituitary gland, housing in Sella turcica. Any alteration in Pituitary gland will further affect the hormonal secretions by this gland. Hence, it can be hypothesised that any change or alteration in dimensions of the Sella turcica may affect the height or weight of the subject. There may be a possibility that patients with enlarged adenoids if left untreated may have short stature or ectomorph body type.

Future research on the hormonal changes secondary to dimensional change in Sella turcica and its effect on physical attribute and body type due to any syndromes or pathologies are yet to be done.

The upper airway morphology is of an interest to Orthodontists because the function of the nasal cavity, nasopharynx and oropharynx can modify the growth of craniofacial structures. This is accordance with the functional matrix theory given by Melvin Moss which states that form and function are interrelated. . In subjects with chronic mouth breathing, an important function of the stomatognathic system i.e respiration is altered resulting in alteration of form that can be expressed as dentofacial abnormalities like narrow maxillary arch, cross bites, clockwise mandibular growth rotation and mandibular retrognathia.

The anatomical abnormalities associated with CLP increase the risk of airway complications. The lack of adequate function in nasopharyngeal area, appearance of the nose, narrowing of the nasal airway due to septal deflections and mucosal hypertrophy of the turbinates, enlargement of adenoid turbinates, all tend to reduce the dimension of the nasal cavity, thereby increasing the resistance to nasal breathing, hinderance in nasal airflow, and disturbances in retropharyngeal function in subjects with cleft lip and palate.

A multidisciplinary approach including plastic surgery, oral surgery , speech therapy , Orthodontics is often required for the management of CLP. An Orthodontist can treat these patients by nasoalveolar moulding, can treat anterior and posterior crossbite, and manage CLP by Orthopaedic appliances or by providing camouflage Orthodontic treatment. In adults with severe skeletal disharmonies, Orthosurgical approach is needed to manage CLP patients.

The nasal airway patency is compromised in CLP patients as a result of presence of functional pharyngeal flap, nasal septum deformities and enlarged turbinates[7].The presence of functional pharyngeal flap is responsible for no or minimal hypernasality but its integrity is lost in the maxillary advancement surgeries for retruded maxilla in CLP patients. Hence there are chances of creating velopharyngeal incompetence in subjects with competent velopharyngeal mechanism prior to surgery. To

prevent hypernasality it is important to preserve the functional pharyngeal flap by limiting maxillary advancement or adding mandibular setback. Considering these associated difficulties, the morphometric evaluation of the pharyngeal airway is, therefore, important in patients with CLP.

Two dimensional analysis of airway had its own drawbacks like difficulty in visualizing complex airway, structures overlapping, image distortion etc. Therefore in order to have a clear visualization of the airway in all the three planes of space, two dimensional imaging techniques have largely been replaced by 3D imaging techniques like CT and CBCT (cone beam computed tomography) where volumetric analysis is possible.

The relationship of airway in subjects with different malocclusions or facial types has been evaluated earlier but very few studies have been conducted to evaluate airway morphology in terms of linear dimensions, volume and minimum cross section area in CLP patients.

The results of these studies were controversial and none of these studies evaluated and compared airway morphology between ULCP and BCLP groups. Therefore it was decided to conduct this study with an aim to evaluate and compare airway morphology by dimensional and volumetric analysis of airway of patients with surgically repaired unilateral and bilateral cleft lip and palate with that of normal subjects using CBCT.

The study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das college of Dental Sciences, Lucknow. The sample was collected from CMDC, Lucknow. A total of 45 CBCT scans of 45 subjects were divided in 3 Groups, Group I had 15 normal subjects without cleft lip and palate, Group II had 15 subjects with unilateral cleft lip and palate(UCLP) and Group III had 15 subjects with bilateral cleft lip and palate (BCLP). All CBCT scans were taken following a standard protocol using CBCT machine (NEWTOM GIANOV 3). The subjects were in upright position and were asked not to swallow and breathe during the scans to minimize the differences in the dimension of the airway.

CBCT scans were converted into DICOM images for pharyngeal airway analysis using Dolphin 3D imaging software. The accuracy and reliability of airway segmentation by Dolphin 3 D software had been tested and proven to be reliable in many of the previous studies. It is advantageous as user can initiate the calculation by selecting and limiting the specific segment of airway.

Scans were orientated in axial, coronal and sagittal plane using Dolphin software. Pharyngeal airway analysis was done which included dimensional analysis, area and volume measurements. Dimensional analysis included evaluation of pharyngeal airway width (PAW) at PNS, tip of soft palate, tip of epiglottis and base of tongue. Area and volume of nasopharynx and oropharynx and minimal cross sectional area (MCA) were calculated for all the groups. After orientation of scans in sagittal view, compartment border were drawn for oropharynx and nasopharynx. Seed points representing the airway in this compartment were marked and airway was sculpted for calculation of Nasopharyngeal and Oropharyngeal area and volume.

The following results and conclusion were drawn from the present study:-

1. Pharyngeal airway insufficiency was seen in both types of cleft subjects (UCLP and BCLP)
2. Nasopharyngeal and Oropharyngeal volume was minimum in BCLP subjects followed by UCLP and normal subjects (Normal subjects > UCLP > BCLP)
3. Inconsistency was seen in area measurement where nasopharyngeal area was higher in cleft subjects in comparison to normal subjects and vice versa for Oropharyngeal area.
4. Dimensionally pharyngeal airway width was minimum at the level of PNS in UCLP subjects and at the level of soft palate and epiglottis in BCLP subjects.
5. The comparable minimal cross section area between cleft and normal subjects suggested all cleft cases are not prone for sleep disordered breathing.

Pharyngeal airway analysis is important in cleft patient, when planning orthopedic or orthosurgical treatment. During Orthosurgical management of cleft cases, single or double jaw surgery is decided not only on the basis of skeletal discrepancy and presence of the functional pharyngeal flap but also on pharyngeal volume. Maxillary advancement surgery can worsen velopharyngeal insufficiency by breaking the integrity of functional pharyngeal flap, hence its better to add mandibular setback in such cases. Maxillary advancement surgery improves the volume more at PNS and soft palate level whereas mandible setback surgery, if done alone can compromise the airway. Further scope of these studies can be directed towards evaluation of pharyngeal airway in subjects treated with orthopedic growth modification procedures, orthognathic surgeries or distraction osteogensis.