ANALYZING RELATION BETWEEN NASAL SEPTUM DEVIATION AND ORAL CAVITY: A HISTORICAL PERSPECTIVE

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***Abstract*— The nose plays a crucial role in the respiratory system as an organ responsible for airflow, as well as warming, humidifying, and cleansing the air. Additionally, it is central to the sense of smell and taste. Nasal breathing is vital for the proper growth and development of the craniofacial complex, as it influences the palate and maxillary growth. Over the years, various kinds of research have been undertaken to study this influence utilizing different clinical and radiographical methods. This review article tries to summarise those researches, their methods and their conclusions.**

***Keywords*— Classification, Craniofacial development, Deviated nasal septum, Nasal breathing, Nose**

1. Introduction

Nose is the prominent structure between the eyes that serves as the entrance to the respiratory tract its normal anatomy is essential for normal breathing pattern which in turn, is desirable for the proper growth and development of the craniofacial and associated dental structures.[1]

The organ can be broadly divided into 2 parts: -

a) External nose

b) Internal nose - the internal nose is further divided by a septum in the centre that is formed by bony parts and septal cartilage.

This septal cartilage is a perpendicular plate that extends from the nasal bones anteriorly to the bony septum in the midline posteriorly, then down along the bony floor. It has a quadrangular shape and its upper half is flanked by two triangular or trapezoidal cartilages called the upper lateral cartilages, which are fused to the dorsal septum in the midline.[2]

The bony part of nose includes, the perpendicular plate of the ethmoid bone that forms the upper part, while the inferior and the posterior part is formed by an independent bone- vomer. The remaining parts of the sphenoidal bone also contribute to the formation of the nasal septum.

The idea of nasal septal cartilage being a key growth centre that influences nasofacial skeletal development was first propagated by Scott (1953). It was later challenged by Melvin moss in 1968, who strongly suggested that the cartilaginous nasal septum is not a primary growth site but at the same time put forward the concept of functional matrix thus pressing on the importance of upper airway space and laminar airflow. [3]

Hence, Etiological factors such as mechanical injuries, nasal polyps, neoplasia, infections, genetic influences, congenital malformations, or any discordance in the development of nasal septum's bony and cartilaginous parts may lead to septal deviations that affect the growth of maxillo-facial and associated structures.[4]

This effect on maxillofacial structure has been studied by various diagnostic means for many years and this review aims to follow the evolution of methodologies to study this correlation.

2. Initiaiton Of Hypothesis

The hypothesis that the nasal septal cartilage is the primary growth center of the upper and mid-facial skeleton found eloquent expression in the work of Scott. His hypothesis is based on the following assumptions:

(1) In the fetal skull, the original nasal capsule and its derivatives are cartilaginous

(2) All cranial cartilaginous tissues (septal, condylar, or in synchondroses) are primary growth centers, by virtue of the undoubted ability of all cartilaginous tissues to undergo interstitial expansive growth

(3) The prenatal appearance of the intramembranous vomer (and of the several endochondral ossification centers of the ethmoid sinuses and the turbinates) the remaining unossified portions of the cartilaginous nasal capsule continue to be capable of such interstitial expansion.[5]

Study data presented by Melvin l. Moss in 1968 strongly suggested that the cartilaginous nasal septum is not a primary growth site, and is not in any way implicated biomechanically in the growth of the middle (or upper) face. Supporting data were obtained from two sources;

1) TERATOLOGICAL:

a) In cyclopia with arrhinencephaly, the normal nasal cavity and septum are absent, although the nasopharynx is present. Despite this, the size and position of both the maxillary complex and the mandible are also normal.

b) Essentially similar findings are reported in holoprosencephaly.

2) EXPERIMENTAL:

Experimental data on the effects of total removal of the nasal septum in young rats show that only dorsal collapse occurs, but that splanchnocranial growth is normal. The application of the theory of functional cranial analysis, to nasal and mid-facial skeletal growth, demonstrated that the growth of these two areas is independent of each other and that the nasal septal cartilage plays a secondary compensatory role, rather than a primary morphogenetic one.[6]

3. EVOLUTION

3.1. CLINICAL DIAGNOSIS

3.1.1. SEPTAL DEVIATION

In the year *1982 Lindsay p. gray* was one of the first researchers to investigate the relationship between nasal septum deviation and maxillo-facial structures. The investigation of septal kin or deviation was carried out with the help of polyethylene struts, 6 mm wide by 2 mm thick. The lubricated strut was inserted upward 3 to 4 mm to get into the nose, then slid along the floor of the nose, hugging the septum.

While inserting the struts he found three kinds of patients, 1) that gave the feeling of normal smoothness (i.e., a straight septum), 2) In a few patients, some irregularity or roughness was felt, 3) Those in which frank obstruction (Le., septal deformity) was appreciable.[7]

3.1.2. MAXILLOFACIAL STRUCTURE

To observe maxillary, palatal, and dental deformities in a few cases clinical diagnosis was followed up by dental casts. While other cases were followed by sectioning and observing the deformity in the septum, symmetry in the size of the turbinates, relationship of vomer to septum and arch of the palate

3.1.3. CORRELATION OBSERVED

He observed that when the septum showed a kink, it was associated with mandibular midline/arch swing, compression and rotation of the left anterior segment, lingual crossbite, and Palatal asymmetry.

He classified the septum into 3 types:-

A (straight)

B (kinked- deformed to one side)

C (deviated – deformed to both sides)

It was observed that type A and type B septal defect was associated with the least and most palatal and dental deformity respectively.[8]

3.2. RADIOCEPHALOGRAMS

The advent of radiological diagnosis revolutionized the field of medicine by providing invaluable insights into the internal structures of the human body. This branch of medicine evolved from the discovery of X-rays by Wilhelm Conrad Roentgen in 1895, the value of this discovery in the field of diagnosis was realized by W A Price in 1900. But, It was in the year 1931 Broadbent-Bolton standardized this technique with development of cephalometer.

Wolfgang in the year *1992* published an article in which the author followed a pair of identical twins, in which one sibling had suffered from nasal trauma at 12 years of age. At the age of 17, the nose was corrected after which the dental casts were made and the radiocephalograms were taken.

In one of the studied patients he observed that although there was severe damage in the septum and nasal pyramid with a history of injury, her maxilla was longer in the sagittal direction than the maxilla of the healthy sibling, whose teeth 14 and 24 had been extracted for orthodontic treatment. Both siblings presented a mirror-imaged retrusion of teeth 11 and 21. This finding pointed out that severe nasal injury at age 12 did not influence the development of the maxilla.[9]

3.3. PA CEPHALOMETRY

Correlation between nasal septum deviation and maxillary transversal deficiency was studied by *Fabiana et al. (2016)* by retrospectively evaluating on 66 posterior– anterior radiographs of subjects with maxillary transverse deficiency.

3.3.1. MAXILLARY TRANSVERSE DEFICIENCY

The maxillary transverse deficiency was clinically diagnosed by an expert orthodontist who utilized the following criteria: maxillary transverse constriction with monolateral or bilateral molar crossbite, no history of orthodontic treatment, prepubertal age, high quality standardized posterior-anterior radiographs.

3.3.2. SEPTAL DEVIATION

Posterior–anterior radiographs were taken by a single trained radiographer with the bipupillar plane parallel to the ground floor and a specific support in order to ensure a standardized position. Each frontal cephalogram were manually traced by the same operator while landmarks and anatomic contours were checked by a second operator.

The following landmarks were used :-

1) Lo (and Lo'): latero-orbital, defined as the intersections between the lateral margin of the orbits and ''cranial linea innominata'' (oblique line).
2) NSm: nasal septum median, the most median central point of the nasal septum.
3) NSi: nasal septum inferior, the most inferior central point of the nasal septum.
4) LoL: the latero-orbital line, connecting Lo–Lo' .
5) VML: the vertical midline, perpendicular to LoL passing trough the midpoint of LoL line (Lom)

The following angles were calculated: –

1) NC: right nasal cavity angle, nc-VML.
2) NC': left nasal cavity angle, nc0-VML.
3) CV: nasal cavity angle, nc–nc' .
4) NSm angle: SNm-VML angle (absolute value).
5) NSi angle: SNi-VML angle (absolute value).
6) ANS angle: ANS-VML anterior nasal spine angle.
7) ASY: asymmetry of the two nasal cavities, the difference between NC and NC' (absolute value).

3.3.3. CORRELATION OBSERVED

They performed a retrospective evaluation on 66 posterior– anterior radiographs of subjects with maxillary transverse deficiency but were unable to find any association between transverse maxillary deficiencies and nasal septum deviations. Moreover, no significant differences were found between the mean nasal cavities dimensions in subjects with transverse maxillary deficiency and the control group.[10]

3.4. OSTIOMEATAL COMPUTED TOMOGRAPHY

As radiology progressed, new imaging modalities were developed, each offering unique advantages in different clinical scenarios. The advent of CT scanning in the 1970s marked a significant milestone in radiological diagnosis. CT scans provided three-dimensional images of the body, allowing for enhanced visualization of soft tissues and internal organs. This innovation greatly improved the accuracy of diagnosing conditions ranging from tumors to vascular diseases. This technology was utilized by kim et al. in 2011 for nasal septum deviation

3.4.1. DIAGNOSIS

To evaluate the correlation between growth differences of the face and nasal septal deviation kim et al. in their study utilized ostiomeatal unit-computed tomography (OMU-CT) scan to quantify nasal septal deviation using, five parameters:-

a) angle of septal deviation [ASD]
b) angle of nasal floor [ANF]
c) angle of lateral nasal wall [ALW]
d) angle of inferior turbinate [AIT]
e) width of IT [WIT].

To quantify the effects on the maxillofacial structures, pre-operative facial photographs were taken and the following distances were measured on both sides of the face midsagittal plane to Zygion (MSP-Zy), Glabella to Exocanthion (G-Ex), Exocanthion to Cheilion (Ex-Ch), and Zygion to Cheilion (Zy-Ch).

3.4.2. CORRELATION OBSERVED

It was demonstrated that there is a strong relationship between deviated nasal septum and facial growth asymmetry.[4]

3.5. PARANASAL SINUS CT

Relationship between the depth of the maxillopalatal arch and deviation of the posterior septum was investigated with the help of paranasl sinus CT by *Akbay et al.* in 2013 by examining 150 different PNSCT and dividing it into 3 group.

First one consisting of the patients who have convex deviation as severe as causing an angle on perpendicular plate, second being patients who have either crest or spur style deviations not blocking nasal passage, also must not cause an internal angle between perpendicular plate and septum or displacement on vomer and the third group is constituting the patients who do not have any septum deviations at all.

The vertical line from the midpoint of lamina cribrosa of ethmoid bone to maxillopalatal bone was taken as the reference to quantify the deviaiton and the following measurements were also recorded to understand the effect of deviation on the palate: (1) Palatal interalveolar length (2) Palatal arch depth (3) Maxillopalatal arch angle (4) Septal vertical length (5) Deviated septal length (6) Deviated septal curve angle and (7) Palatal arch depth/palatal inter-alveolar length.[11]

3.6. CT AND 3-D GEOMETRIC MORPHOMETRY

3.6.1. SEPTAL DEVIATION

To further investigate the relationship between nasal septum and dentofacial structures *Hartman et al. in 2016* utilized three-dimensional (3D) geometric morphometric techniques that enabled the investigator to account for the overall morphology of the nasal septum and hence allowed accurate assessment of the magnitude of nasal septal deviation across the entire septum.

To quantify the magnitude of deviation, first the nasal septum was manually segmented from the anterior to posterior edges. Next, the volume of a modeled non-deviated septum following the borders of the nasal septum was calculated. Both nasal septal volume and the non-deviated volume were segmented at constant thickness of 1.0 mm to control for potential variation in mucosal and cartilage thickness. Then they measured overall size of the nasal septum and nondeviated septal model by calculating the volume of the resulting 3D septal reconstructions.

Individual nasal septal deviation values were calculated as a percentage of nasal septal volume relative to the volume of the modelled non-deviated septal volume [(nasal septal volume/non-deviated volume) x 100].

3.6.2. MAXILLOFACIAL STRUCTURES

In order to evaluate the relationship between nasal septal deviation and craniofacial form, 41 landmarks from the facial skeleton were collected by Hartman in 2016:

1 Nasion, 2 Rhinion, 3 Alare (right), 4 Alare (left), 5 Anterior nasal spine, 6 A point, 7 Prosthion, 8 Lateral incisor/canine septum (right), 9 Lateral incisor/canine septum (left), 10 Ectomolare (right), 11 Ectomolare (left), 12 Zygomaxillare (right), 13 Zygomaxillare (left), 14 Orbitale (right), 15 Orbitale (left), 16 Frontomalare orbitale (right), 17 Frontomalare orbitale (left), 18 Frontomalare temporale (right), 19 Frontomalare temporale (left)

, 20 Jugale (right), 21 Jugale (left), 22 Superior zygomaticotemporal suture (right), 23 Superior zygomaticotemporal suture (left), 24 Alveolar/palatal process junction at 25% cross-section (right), 25 Intermaxillary suture at 25%, 26 Alveolar/palatal process junction at 25% cross-section (left), 27 Alveolar/palatal process junction at 50% cross-section (right), 28 Intermaxillary suture at 50%, 29 Alveolar/palatal process junction at 50% cross-section (left), 30 Alveolar/palatal process junction at 75% cross-section (right), 31 Intermaxillary suture at 75%, 32 Alveolar/palatal process junction at 75% cross-section (left), 33 Posterior nasal spine Palatal

34 Intersection between nasal septum and cribiform plate at 50%, 35 Lateral most aspect of nasal cavity at 50% cross section (right), 36 Lateral most aspect of nasal cavity at 50% cross section (left), 37 Lateral aspect of nasal floor at 50% cross section (right), 38 Lateral aspect of nasal floor at 50% cross section (left), 39 Superior aspect of nasal septum at 100%, 40 Lateral most aspect of nasal cavity at 100% cross section (right), 41 Lateral most aspect of nasal cavity at 100% cross section (left).

3.6.3. CORRELATION OBSERVED

The results indicated that while there was no correlation between septal deviation and the overall magnitude of asymmetry, septal deviation was associated with asymmetry primarily in the nasal floor and the palatal region, particularly evident was the lateral deviation of the nasal floor in the posterior region when compared with the anterior nasal floor.[12]

3.7. <u>CBCT</u>

The origins of CBCT can be traced back to the early 1990s when a team of researchers led by Mozzo et al. introduced the concept of volumetric imaging using a cone-shaped X-ray beam. Their pioneering work laid the foundation for the development of CBCT scanners that could capture a full 3D representation of the maxillofacial structures in a single scan, which greatly helped the research in the maxillofacial region.

3.7.1. DIAGNOSIS

Wanzeler et al. in 2017 to ascertain relation between nasal septum deviation (NSD) and oropharynx volume in different facial patterns utilized CBCT examinations. The images were evaluated in three stages. 1st stage images were grouped into facial types: dolichofacial, mesofacial and brachyfacial for which the following measurements were used (1) SN-Gn (normal - 67°), (2) SN Go-Gn (normal - 32°) and (3) McNamara y-axis (normal - 90°). In the second stage, reliable oropharynx volume measurements were performed with ITK-SNAP software. In the third stage, the images were evaluated according to the presence or absence of NSD in the meatus nasi medius. the analysis was performed using the axial and coronal tomographic images analyzed with InVivoDental Demo (1.0.511.0) software.

3.7.2. CORRELATION OBSERVED

They discovered lower prevalence of NSD in the dolichofacial group compared with the brachyfacial and mesofacial groups, they also found that there was a very strong positive relation between the presence of NSD and oropharynx space volume.[13]

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