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ASSESSMENT OF GENETIC AND ENVIRONMENTAL CONTRIBUTION TO MALOCCLUSION AND CRANIOFACIAL COMPLEX: A CASE STUDY OF TWINS

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ABSTRACT: Relative contribution of genes and the environment as the etiology of malocclusion has been a matter of controversy throughout the twentieth century and first decade of twenty first century. As the matter of fact the complex process of human growth begins with basic genetic inheritance but shaped by environmental factors.Contribution of how genetic and environmental factors contribute to variation in dental and craniofacial morphology is entangled by twin studies. Even though malocclusions appear to be acquired, fundamental genetic control of craniofacial form often diverts twins into comparable physiologic responses leading to development of similar malocclusions.The purpose of this monozygotic or identical twins case report is to assess the variations within cranio-dento-facial complex influenced by the genetic and environmental factors.

KEYWORDS: Malocclusion, Twin studies, Monozygotic, identical twins.

INTRODUCTION

From the time since 1891 when Kingsley stated inheritance as a major factor in the development of malocclusion, the question of the etiology of malocclusion whether environmental or genetic has been debated among orthodontists. Edward H. Angle during the early part of the 1900's believed that malocclusions arise from local factors, proposing the view of environmental influences responsible for the determination of occlusion. Mossey PA stated that genetic mechanisms are clearly predominant during embryonic craniofacial morpho-genesis, but environment is also thought to influence dentofacial morphology postnatally, particularly during facial growth.[1]Lauweryns et al stated that twins serve as a unique resource for evaluating the interactions between genetic and environmental effects, helping to provide a more scientifically based rationale for orthodontic treatment.[2] For studying the fascinating phenomenon of mirror-imaging the dentitions and faces of twins provide a good opportunity, in which one twin mirrors the other for one or more features.[3]This case report describes about a pair of monozygotic twins who are brought up in similar environment showing similarity in facial morphology, dentition, and craniofacial complex establishing the fact that malocclusion is possible interaction between hereditary and environmental factors.

Case report

A pair of female twins aged 13yrs reported to department of pedodontics and preventive dentistry with chief complaint of forwardly placed upper front tooth. Mother gave the history of twins sleeping with open mouth and mouth breathing. Medical history was non-contributory. On extra oral examination both the twins had similar facial appearance and form from the frontal and lateral view with mesoproscopic face, convex profile and posterior divergence. Skin of forehead showed acne vulgaris. Lips were incompetent with short, hypotonic upper lip and deep mentolabial sulcus. **(Fig. 1, Fig.2)**

Both the twins had similar dentition with angles class I molar and canine relation. Overjet was 9 mm and overbite of 5mm.Maxillary arch in both the twins was identical mirror images but mandibular arch showed slight variation in terms of anterior teeth crowding**(Fig.3).** A study model comparison of maxillary and mandibular dental arches was made[4] **(Table 1**). The mesio-distal dimension and shape of central and lateral incisors were same in maxillary and mandibular arches of both the twins. Overall Bolton's ratio in twin 1 was 92.3% and 91.9% in twin 2.

Fig. 1 – Frontal view of twins

Fig. 2 (a) – Profile view of Twin 1

Fig. 2(b) - Profile view of Twin 2

Table 1: Comparison of dental arches on study models

Measurement	Arch			
	MAXILLARY ARCH		MANDIBULAR ARCH	
	Twin 1	Twin 2	Twin 1	Twin 2
Arch perimeter	81mm	81mm	64.5mm	66mm
Arch length	47.5mm	47.5mm	38.5mm	34.5mm
Intermolar width	46.5mm	46.5mm	40mm	39.5mm
Intercanine width	36mm	36mm	26.5mm	25mm
Intermolar width	40mm	41mm	30mm	36mm
Anterior segment length	19mm	19mm	11.5mm	10mm
Posterior segment width	26mm	26mm	30mm	25mm
Maxillary depth	18mm	18mm		

Fig. 3. Intraoral occlusal view of Maxillary arch (A) and Mandibular arch (B) of Twin 1

Fig. 3. Intraoral occlusal view of Maxillary arch (C) and Mandibular arch (D) of Twin 2

Table.2.Comparison of linear measurements on cephalogram

	Twin 1	Twin 2
Linear measurements		
Anterior cranial base (S-N)	61mm	62mm
Posterior cranial base (S-Ba)	37mm	35mm
Anterior facial height (N-Me)	95mm	95mm
Upper anterior facial height (N-ANS)	38mm	38mm
Lower anterior facial height (ANS-Me)	59mm	58mm
Posterior facial height (S-Go)	60mm	58mm
Mandibular length (Go-Me)	55mm	56mm
Angular measurements		
SNA	80^0	80^0
SNB	74^0	74^0
ANB	6^0	6^0
Saddle angle (N-S-Ar)	126^0	133^0
Gonial angle (Ar-Go-Me)	129^0	131^0

Anterior Bolton's ratio in twin 1 was 76.9% and 76.4% in twin 2. Clinical tests confirmed the mouth breathing habit. Both the twins had second degree adenoid obstruction in which the adenoid tissue was confined to the upper half (<50%) of the rhinopharyngeal cavity. This condition is moderate or discrete adenoid hypertrophy, and adenoidectomy is not required.[5]So habit interception can be carried out.

On lateral cephalogram linear and angular measurements were recorded. There was concordance in terms of linear measurements among and almost nearly matching angular measurements among the twins. **(Table 2)**When compared to twin 1, in twin 2 upper incisors were more proclined. Hence there was difference in interincisal angle and nasolabial angle in both the twins. Maxillo-mandibular length and their difference were similar in both the twins. **(Table 3)**

Discussion

Markovic MD stated that monozygotic twins share twice the amount of genetic material as dizygotic twins. Greater similarity between monozygotic versus dizygotic twins would indicate a genetic influence.[6] Identical twins tend to be raised in similar environments and that this could contribute to the extreme similarity in dental and facial development.[7] In the present case facial form and appearance of the twins were identical with Acne vulgaris on the forehead. For Acne vulgaris Genetic influence is thought to be the cause in 80% of cases.[8]

While comparing monozygotic (MZ) and dizygotic (DZ) twins Lundström A found that in class I 87.3% of MZ twins and 84.6% of DZ twins show concordance in terms of tooth size and occlusion.[9] Comparing the size and morphology of teeth as well as facial form Horowitz and Hixon concluded strong influence by hereditary factors[10] and mesiodistal width of the teeth, anterior tooth ratio are genetically influenced.[11] Above findings were elicited in the present case with twins having similar facial form, occlusion, size and morphology of tooth with similar overall and anterior Bolton's ratio.

Maxillary arch of both twins in this case were identical mirror images in terms of form and size which was in accordance with Detlefsen JA who stated that arch shape and size were inherited characteristics [12] but there was difference in mandibular arch size and form. According to Everett and Matthews, mandibular arch width (as defined by intercanine and intermolar width) and as well as mandibular arch form to be under significant genetic control[13] which was not seen in the present case. Shapiro BL and Riquelme A et al while comparing palatal dimensions in twins found that there is significant genetic contribution to palatal height, width[14]and length[15] which was seen in the present case with twins having similar palatal width, height and length.

Corruccini RS et al while identifying genetic and environmental determinants of dental occlusion variation in twins stated overbite and overjet to be under, at most, moderate genetic control and to be predominately determined by environmental influences.[16] In the present case overbite and overjet was similar in both the twins, possibly because twins being raised in similar environment and less of genetic control. This is in accordance with King L et al that in a given genetically influenced facial types and growth patterns, siblings are likely to respond to environmental factors (e.g., reduced masticatory stress, chronic mouth-breathing) in similar fashions.[17]

Reddy YM et al determined the effect of genetic and environmental factors on craniofacial complex in a twin study by cephalometric analysis and found that linear parameters are under strong genetic control [18] which is elicited in the present case. Angular parameters which are under environmental control[18] were almost similar the possible reason may be that both the twins being raised in similar environment.

In unravelling the mysteries of how our body symmetry is determined and clarifying how genetic factors contribute to oral diseases and disorders multi-disciplinary studies of twins, molecular geneticists and twin researchers with input from dentists holds great promise for the future. According to Lundström A observations by dentists provide valuable insights into how genes and the environment interact during development.[9]

Finally by studying this case of twins we can say that twin studies will keep throwing light on relative influence of genetics and environmental factors in the etiology of malocclusion.

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TABLE 3: COMPARISON OF CEPHALOMETRIC PARAMETERS OF TWINS

Parameters	Twin 1	Twin 2
SNA	80^0	80^0
SNB	74^0	74^0
ANB	6^0	6^0
Go Gn to SN	35^0	34^0
Upper incisor to N-A (mm)	10mm	12mm
Upper incisor to N-A (angle)	36^0	46^0
Lower incisor to N-B (mm)	10mm	10mm
Lower incisor to N-B (angle)	42.5^0	43^0
Interincisal Angle	96^0	90^0
N perpendicular to Point A	2 mm	5mm
N perpendibular to pogonion	-4mm	-4mm
Facial axis	-3^0	-3^0
Mandibular plane angle	28^0	30^0
Eff.Max.Length	75 mm	76 mm
Eff.mand.Length	94 mm	95 mm
Maxillomandibular difference	19 mm	19 mm
Lower ant.face height	59 mm	58 mm
Upper to point A distance	11 mm	14 mm
Lower incisor to APO line distance	6 mm	7mm
Nasolabial angle	72^0	70^0
Anterior facial height (N-Me)	95mm	95mm
Posterior facial height (S-Go)	60mm	58mm
Jarabacks ratio	63.15	61.05
Saddle angle (N-S-Ar)	126^0	133^0
Gonial angle (Ar-Go-Me)	129^0	131^0
Upper lip to esthetc line (E - line)	3mm	3.5mm
Lower lip to esthetic line (E- line)	5mm	6mm
Overjet	9mm	9mm
Overbite	5mm	5mm

Fig.4A. Lateral cephalogram of Twin 1

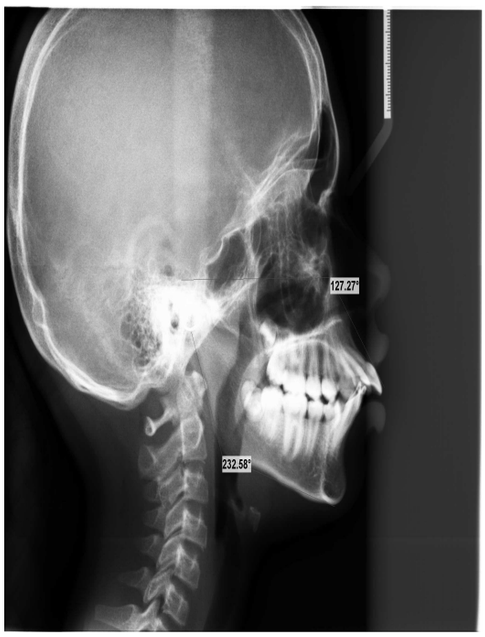

Fig.4A. Lateral cephalogram of Twin 2

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