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The genetic and environmental interaction behind malocclusion: Case report of two twins

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Abstract
Background: Genetic and environmental contribution in the etiology and shape of malocclusion has long been a controversy for the authors. In fact, even though craniofacial deformations are the result of both genetic and environmental factors, there is irrefutable evidence for the high genetic control on craniofacial development and for the significant genetic influence in many dental, occlusal and skeletal variables. The aim of this twin's case report is to clinically show the role of each of these two factors on the expression of abnormalities and particular traits.
Case presentation: The case reflect 10-year-old twins who consulted for their anterior overlap. The comparison between the twins is done through clinical and cephalometric investigation. The clinical examination revealed a great resemblance between the two patients both at the extra-oral (ortho-frontal profil, nasolabial angle, the shape of the forehead, cervico-chin distance) and intra-oral view (Palato-position of the maxillary lateral incisors, molar class I, mandibular arch perfectly identical with mirror effect), Cephalometric analysis revealed a very high morphological similarity (identical skeletal class III, biproalveolia, hyperdivergenc and the position of mandibular incisor).
Conclusion: The existence of a very important genetic control on craniofacial development and the installation of dysmorphosis is undeniable, in particular on skeletal class III and hyperdivergence. But the severity of these dysmorphosis can also be increased by environmental and behavioral factors.

Keywords: genetics, environment, malocclusion etiology, twins

1. Introduction
Malocclusion is a developmental problem inducing a deviation from the normal or ideal occlusion. It's known to be the manifestation of the genetic and environmental interaction on craniofacial development. Genetic factors are thought to predominate during embryonic craniofacial morphogenesis, while environmental factors are said to have a postnatal influence on dentofacial morphology, particularly during the growth period [1-4]
Several authors have attempted to differentiate between the genetic and environmental aspects behind the malocclusions. For this, the investigation of twins has proven to be a powerful tool for identifying and explaining the role of each of these two factors on the expression of abnormalities and particular traits [5, 6]
The present clinical case describes a pair of twins showing high similarity in craniofacial and occlusal morphology. Their identical skeletal dysmorphosis in all three directions of space would argue for the important role of genetics in the development of malocclusions.

Case presentation
A 10-year-old twins in good general health presented to the dento-facial orthopedics department with anterior malocclusion as main concern. No history of medical or dental treatment was declared.
Extra-oral examination showed for the two patients a symmetrical face, an increased facial length, a smile with apparent maxillary incisors, a plate and orthofrontal profil and a correct nasolabial angle. (Figure 1,2)

Fig 1: Extra-oral views of twin-1

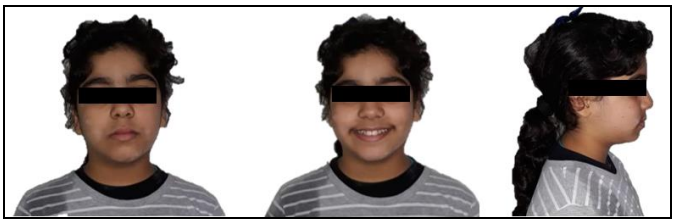


Fig 2: Extra-oral views of twin-2

In the intra-oral examination, the twins showed a complete permanent dentition, a maxillary arch with palateversion of lateral incisors (12 and 22), canine ectopia (13 and 23) with a much greater degree of severity in twin 1, a mandibular arch with a real mirror image in both twins, reflecting an anterior overlap, left and right molar class I occlusion, coincidence of interincisal midpoints with the median sagittal plane, a maxilla circumscribing the mandible in the transverse direction, and a 1mm overjet and overbite. (Figure 3, 4)

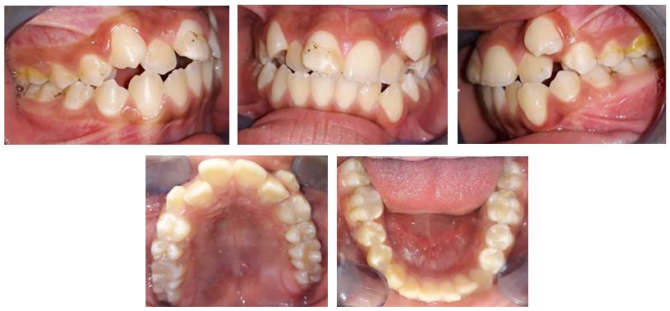


Fig 3: Intra-oral views of twin-1

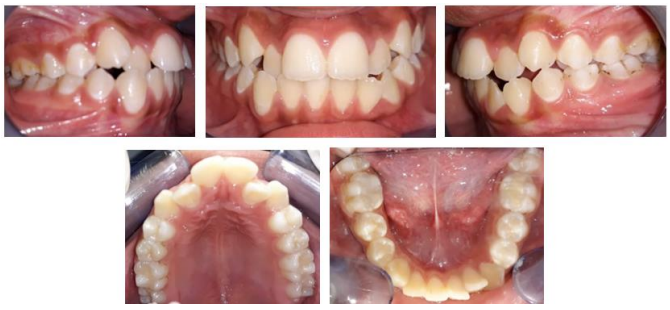


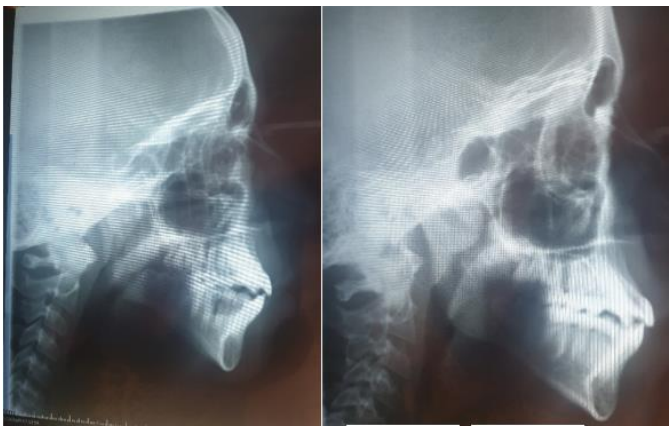
Fig 4: Intra-oral views of twin-2

Cephalometric analysis revealed a significant resemblance between the two patients in their normal and pathological values.

According to clinical and cephalometric data, we could make the following diagnosis:

- A slight skeletal class III (Twin 1 AoBo = -3 ; Twin 2 AoBo = -4)
- Birétrognathy (Twin 1 SNA = 74 et SNB = 72 ; Twin 2 SNA = 78 et SNB = 76)
- Incisors protrusion (Twin 1 I to i = 114 ; Twin 2 I to I = 111)
- Hyperdivergence (Twin 1 GoGn/Sn = 44° et FMA = 34 ; Twin GoGn/SN = 43° et FMA = 33)

The superposition of the cephalometric tracing of the two twins revealed a very high morphological similarity at the level of the craniofacial structures, the anterior and posterior facial height, the sagittal dimension of the mandible, and the position of the lower incisor on its symphysis. (Figure 6)



		Twin-1	Twin-2
SNA	82±2	74	78
SNB	80±2	72	76
ANB	2±2	2	2
AoBo	0±2	-3	-4
I to NA	22	30	34
I to NA	4	7	8
i to NB	25	33	35
i to NB	4	8	8
I to i	131	114	111
Pog to NB		1	1
GoGn-SN	32±5	44	43
FMA	25±3	34	33
FMIA	67±3	52	52
IMPA	88±3	94	95
Angle Z	73	61	66
Ht Faciale Ant	65	66	65
Ht faciale Post	45	36	40
Index facial	0,69	0,54	0,61

Fig 5: Lateral cephalometrics of the two twins

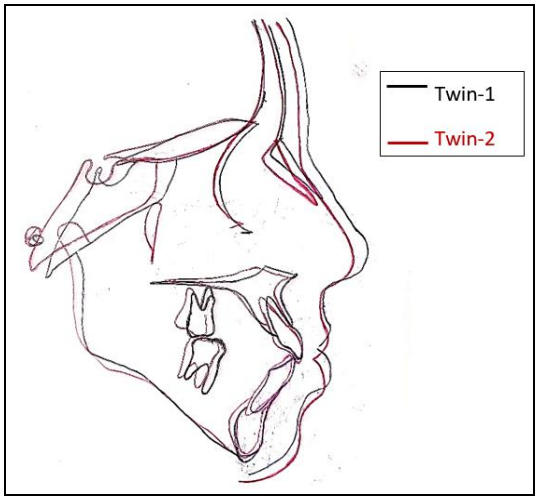


Fig 6: Lateral cephalometrics superposition

Discussion

It is now known through research and studies and also clinical perceptions, that heredity and the environment are two factors which strongly influence craniofacial development and play an important role in the development of dental malocclusions [7]. However, even if an environmental modification alters the development of a phenotype at a particular time, the morphology already present cannot easily change unless this environmental modification is sufficient and strong enough to alter the pre-existing structure [8, 9]. This controversy regarding the main etiology of dental malocclusions has aroused the interest of several authors who have conducted various studies to understand this complex interaction between genetics and the environment. For this, the study of twins has been one of the most effective methods to identify and explain the role of genes and environmental factors on the expression of a particular trait or dysmorphosis. Studying the morphological differences in twins with identical genotypes is a very powerful tool to better elucidate the environmental influence on craniofacial morphology [5].

Many cephalometric studies have explored the skeletal pattern in twins. A large majority of investigations have reported the predominant genetic influence on mandibular position and facial height. Sreedevi et col [10] studied the cephalometric analysis of 19 twins and reported that the anterior facial height, mandibular morphology and position of the mandibular incisor are under significantly elevated genetic influence. This was in agreement with the results of Manfredi et col's study [11] which reported that facial height and mandibular morphology are under very significant genetic control in twins. Pang et Coll [12] conducted a cephalometric study on 89 growing pairs of twins and reported statistically significant results for both environmental and genetic effects on craniofacial development, and suggested that early orthodontic treatment would have great benefit thanks to its influence on sagittal and vertical growth of bone bases. Johannsdottir and col [13] also reported through their study, the predominant genetic factor for the position of the mandibular arch, the anterior and posterior facial height, as well as the dimension of the base of the skull. Horowitz and col [14] found a significant genetic component in corpus length and facial height.

The present clinical situation illustrates the results previously cited, and describes the occlusal and skeletal resemblance of two 10-year-old twins living in the same environmental context and presenting the same craniofacial dysmorphoses (skeletal class III and hyperdivergence). The clinical examination revealed a great resemblance between the two patients both at the extra-oral view (ortho-frontal profil, nasolabial angle, the shape of the forehead, cervico-chin distance) and at the intra-oral view (Palato- position of the maxillary lateral incisors, molar class I, mandibular arch perfectly identical with mirror effect) except canine ectopia which is more severe in the twin 1.

Cephalometric analysis of the two patients showed significant similarity. Indeed, the two twins present a slight skeletal class III, a biproalveolia, and a slightly more pronounced biretrognathia in the twin 1. In addition, their hyperdivergence (GoGn / SN, FMA) and the position of their mandibular incisor (I to NB , IMPA) are perfectly identical.

This clinical situation confirms the results of studies carried out on twins, which have reported the very important influence of genetics on the development of craniofacial structures. However, the multifactorial etiology of any malocclusion is a fact no one can deny and even environmental factors play an important role in the variability of its severity.

Conclusion

All the results obtained through the various studies have led us to conclude the existence of a very important genetic control on craniofacial development and the installation of dysmorphosis, in particular on skeletal class III and hyperdivergence. But the severity of these dysmorphosis can also be increased by environmental and behavioral factors.

However, more genetic studies are needed in order to clearly determine the genes leading to a particular skeletal variability. Rapid development in this area could lead to genetic correction of genetically controlled dentofacial anomalies and malocclusions, possibly in the near future.

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