

Mirror-image phenomenon in Turkish monozygotic twins: A report of 3 cases

Fenomen lustrzanych odbić u tureckich monozygotycznych bliźniąt – opis trzech przypadków

Damla Torul^{A–F}, Mehmet Melih Omezli^{A,C,E,F}

Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Ordu University, Turkey

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Address for correspondence

Damla Torul
E-mail: damlatorul@gmail.com

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Abstract

Due to the special circumstances and the pre-natal environment in twin gestations, disruptions in the development of the embryo are more frequently observed in twin births as compared to singleton births. Twin research provides an excellent model to explore the etiology of disruptions in craniofacial biology. Mirror imaging (MI) is a special manifestation of twinning, and the elucidation of the etiology of this phenomenon is important to understand the biological mechanisms which underlie congenital defects, like orofacial clefts, and to provide insight into left-right asymmetry.

The aim of this paper was, therefore, to present 3 pairs of Turkish monozygotic (MZ) twins with MI dental features, and to contribute to the knowledge of the MI phenomenon in the literature. We examined 2 male and 1 female MZ twin pairs clinically and radiographically in terms of their MI features. Mirror-image features in dental and other ectodermal structures were detected in all the twins. Understanding the biological mechanisms of MI provides broad insight into preventive measures and treatment protocols. Furthermore, the presence of MI features may lead to the detection of other MI pathologies in twins.

Key words: asymmetry, identical twins, mirror image

Słowa kluczowe: asymetria, bliźnięta identyczne, lustrzane odbicie

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Introduction

Over the centuries, twinning and its unique features have been a valuable source for exploring the relative contributions of nature and nurture to various phenotypic traits and pathologies in humans.^{1,2} Mirror imaging (MI) is a special manifestation of twinning, also known as reverse asymmetry, in which one member of a twin pair 'mirrors' the other in 1 or more features.^{1,3,4} The underlying biological mechanisms of MI are still not clear, but preliminary evidence in the literature suggests that reverse asymmetry may be a reflection of a genetically mediated embryological event. Also, it has been suggested that MI is epigenetically linked to the timing of twinning, and therefore the type of placentation.^{4,5} Some aspects of this phenomenon are estimated to occur in 25% of monozygotic (MZ) twins and are typically observed in the tissues derived from the ectoderm; they comprise dentation, hair whorls, dermatoglyphics, eyesight, nevi, handedness, and the cerebral hemispheres.^{1,3,6} In the literature, several MI features and pathologies have been reported.^{3,6-10}

The aim of this article was to present 3 pairs of Turkish MZ twins with MI dental features, and to contribute information about the MI phenomenon to the literature.

Case report

Two male and 1 female MZ twin pairs (5, 9 and 10 years old, respectively) were referred to the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry at Ordu University in Turkey for routine examinations. Written informed consent to participate in the study was obtained from the parents of the twins. The zygosity of the twins was determined according to a standard zygosity questionnaire and blood groups.¹¹ Handedness was measured with a hand preference (HP) inventory based on the Edinburgh Handedness Inventory.¹²



Fig. 1. Front view of twins A₁ and A₂

Hand use was evaluated during drawing, writing, using scissors, throwing a ball, cutting with a knife, using a spoon, using a toothbrush, using a broom, taking a lid off a box, and dealing cards. The inventory awarded 2 points for each right-handed action, 0 points for left-handed actions, and 1 point for mixed or unclear preference, with the total score ranging from 0 (left-handed) to 20 (right-handed).

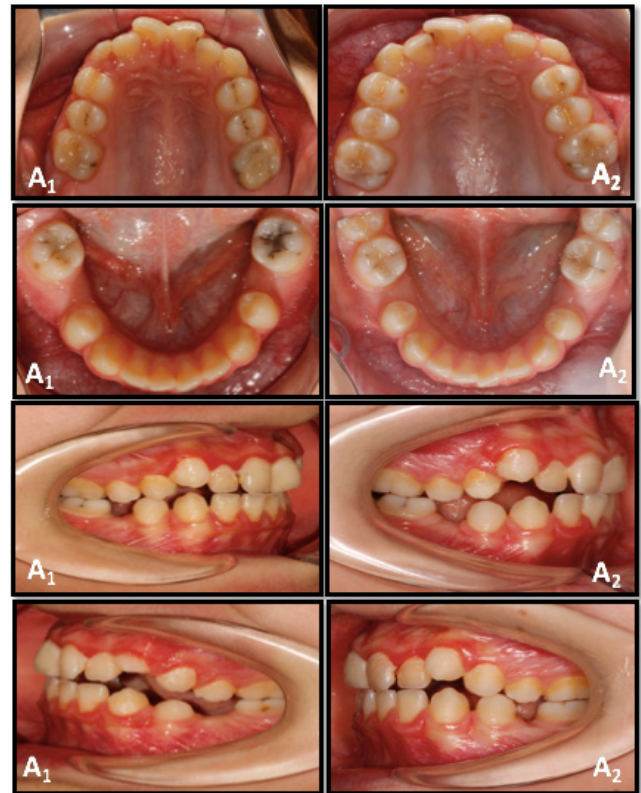


Fig. 2. Intraoral photographs of A₁ and A₂

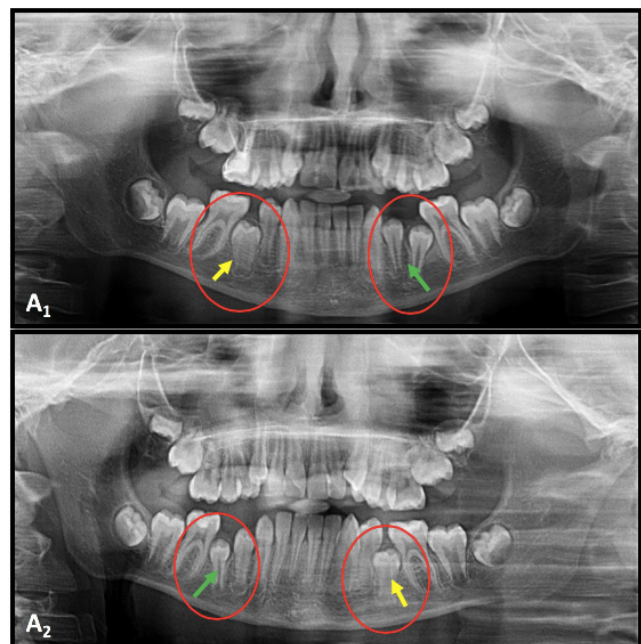


Fig. 3. Panoramic radiographs showing the mirror-image (MI) dental features of A₁ and A₂ (arrows)

The twins' medical and dental histories were noncontributory. All 3 twin pairs were subjected to clinical and radiographic examinations. Panoramic and lateral cephalometric radiographs were obtained from all 3 pairs.

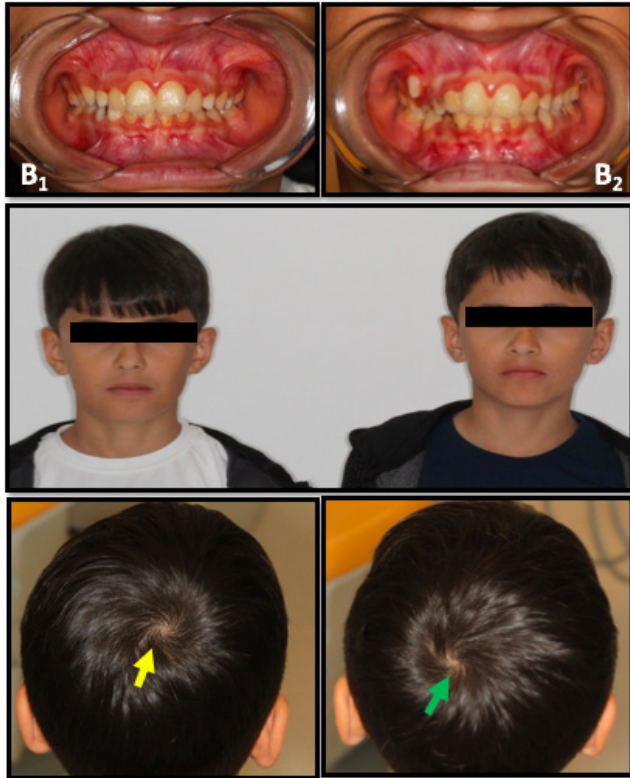


Fig. 4. Front view and hair whorls of twins B₁ and B₂

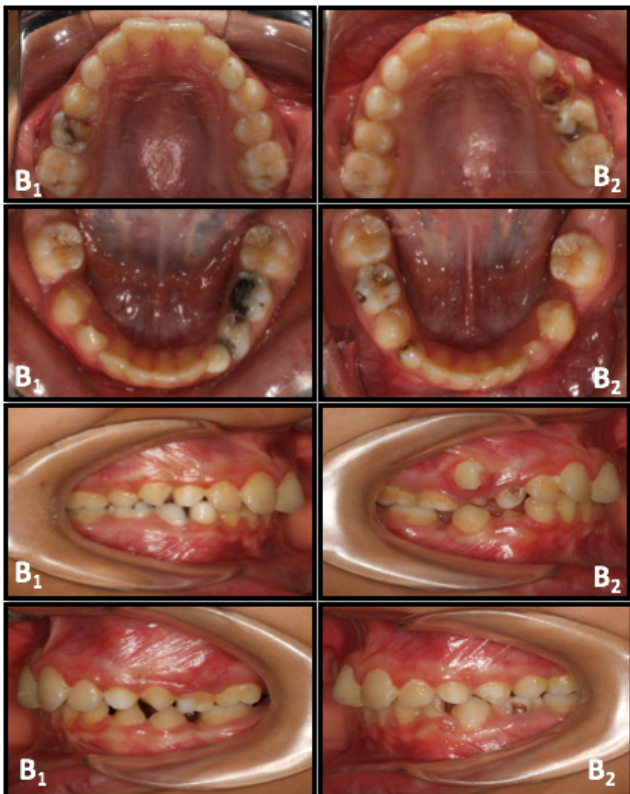


Fig. 5. Intraoral photographs of B₁ and B₂

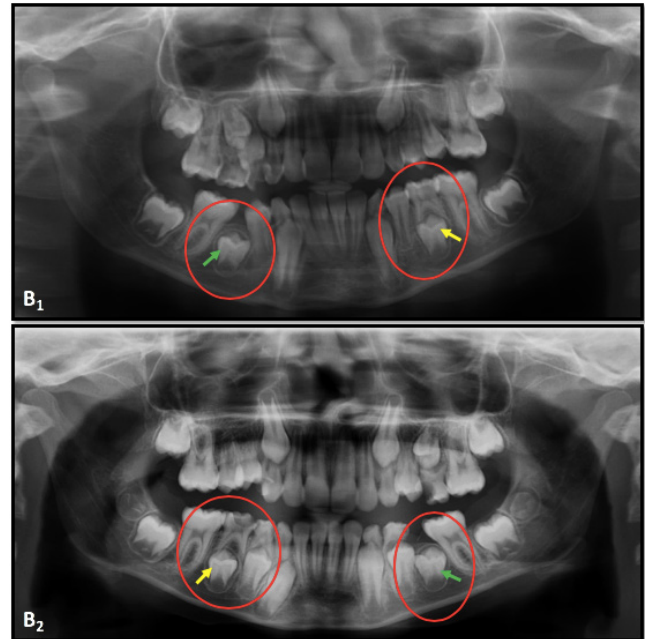


Fig. 6. Panoramic radiographs showing the MI dental features of B₁ and B₂ (arrows)

Clinically, twins A₁ and A₂ were at the mixed dentition stage, with the mandibular premolar teeth showing MI asymmetries (Fig. 1–3). Also, A₁ was right-handed and kicked with his right foot, whereas A₂ was left-handed and kicked with his left foot.

Twins B₁ and B₂ were also at the mixed dentition stage and had MI features in their dentition. The hair whorls of B₁ and B₂ were in opposite directions: one's clockwise, and the other's counter-clockwise (Fig. 4–6).

Twins C₁ and C₂ were also at the mixed dentition stage and showed MI features in the eruption pattern of their mandibular central incisor teeth (Fig. 7–9).



Fig. 7. Front view of twins C₁ and C₂

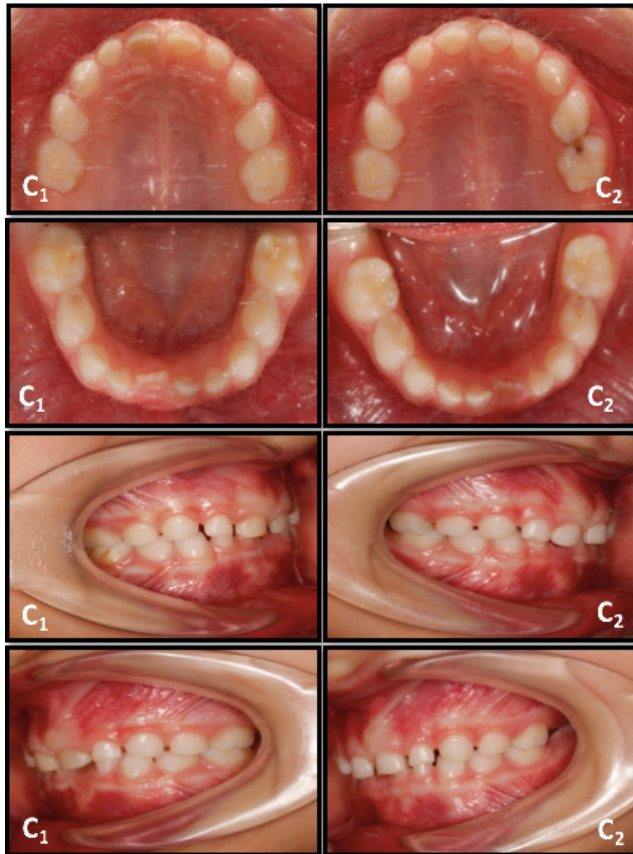


Fig. 8. Intraoral photographs of C₁ and C₂

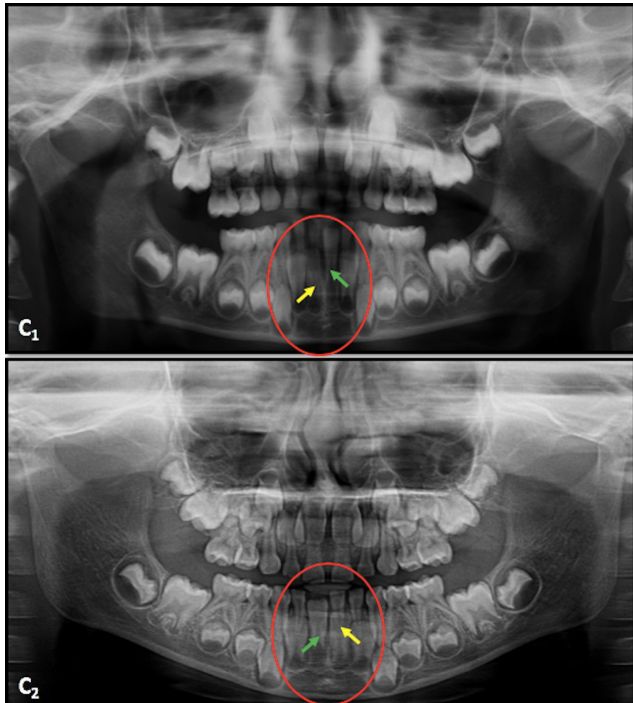


Fig. 9. Panoramic radiographs showing the MI dental features of C₁ and C₂ (arrows)

Discussion

Mirror imaging – a special manifestation of twinning, also referred to as reverse asymmetry – occurs in MZ twin pairs, who are considered to have identical features.⁹

Rather than an epiphenomenon, MI is considered a biological polarization that describes the role of biochemical, genetic, psychological, and environmental factors in the occurrence of not only reverse asymmetry, but also opposite tendencies in the development of personality, sex orientation as well as psychiatric and pathological conditions.^{2,13}

The exact biological pathways of this polarization are still not clearly understood. Mirror-image asymmetries are believed to occur as a result of the blockage of predetermined cells, leading to the establishment of a second reversed morphogenetic gradient.⁹ Also, the maldistribution of the homeobox genes which define the anterior-posterior axis and the early molding of the embryo during splinting has been reported to deteriorate regulatory balance.¹⁴ Another explanation of MI is the timing of the cleavage of the zygote, and therefore the type of placentation.² Regarding placentation, MZ twins can be grouped as dichorionic/diamniotic (cleavage occurring 1–5 days post-conception, before implantation), dichorionic/monoamniotic (cleavage occurring 6–9 days post-conception, after implantation) and monochorionic/monoamniotic (late cleavage, probably occurring 9–10 days post-conception^{2,5}) It has been noted that the basic symmetry of the embryo occurs at around 7–8 days, when the amnion is differentiating.⁴ If the zygote divides in late embryogenesis, this may result in asymmetries, and the incomplete redefinition of these asymmetries may lead to discordance for the left-right orientation and different degrees of MI in MZ twin pairs.^{4,9} However, according to Badzakova-Trajkov et al., the occurrence of MI asymmetries is largely due to chance.¹⁵

The MI phenomenon typically affects the tissues derived from the ectodermal layer, which develops early.^{1,6} Although situs inversus or heterotaxy syndrome have been reported in internal organs, this phenomenon rarely affects mesodermally derived organs.^{14,16} Mirror-image ectodermal features, such as the tooth eruption pattern, eyesight, hair whorls, dermatoglyphics, the laterality disturbances of the cerebral hemispheres, and non-right handedness are frequently observed in MZ twin pairs.^{1,3,6} Mirror-image handedness is presumed to be a reflection of variations in cerebral lateralization among twins.⁴ Nearly 30% of the reported MZ twin pairs have MI handedness.⁵ In the present cases, only twins A₁ and A₂ presented discordant handedness. Also, MI hair whorls were observed in twins B₁ and B₂.

The bilateral symmetrical development of dentition commences at about 4 weeks in utero and extends until physical maturity at about 21 years post-natally. Thus, dentation provides a good model to explore the fascinating phenomenon of MI.^{1,4} Dentition is strictly under genetic control. Thus, MI asymmetries in dental features provide insight into genetic control over phenotypic expression, and also other etiologic factors of the asymmetric developmental mechanisms in MZ twins.⁹

Mirror-image dental fusion, hypodontia, germination, and supplemental teeth have been reported in the literature.^{9,10} Song et al. reported a case of twins presenting with hip cysts, who also had an MI crossbite in their dentition.² They suggested that, depending on the degree of MI, multiple organ systems can be affected; thus, if one of the MZ twins presents with a medical problem, it may be logical to perform a diagnostic workup on the other twin as well.² In all 3 of our cases, MI dental features were detected in the tooth eruption patterns and impaction.


Mirror-imaging pathological conditions have also been noticed in MZ twins. Zhou et al. described a pair of MZ twins who developed MI arachnoid cysts in the temporal fossa.⁶ The MI first and second branchial arch syndrome associated with cleft lips and palates was reported in MZ twins by Satoh et al.⁷ In another case report, Brent described the surgical management of twins who were afflicted with MI unilateral microtia.⁸

Even when physical characteristics are concordant, MI monozygotic twins can exhibit discordance in psychiatric conditions. Lohr and Bracha reported a twin pair in which one was diagnosed with bipolar disorder and the other with schizophrenia.¹⁷

In conclusion, the MI phenomenon may cause biological polarization, reflected in twin pairs as reverse asymmetrical physiological features or pathological conditions, in different degrees. Our report on 3 cases of MZ twins with MI dental features contributes to the understanding of the limitations of genetic control over dental phenotypic expression and possible epigenetic origin. We also suggest that twin pairs who show 1 or more MI features should be examined extensively for medical, dental and psychological asymmetry.

ORCID iDs

Damla Torul  <https://orcid.org/0000-0003-2323-606X>

Mehmet Melih Omezli  <https://orcid.org/0000-0002-6606-6593>

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