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## Case report

## Management of maxillofacial hard and soft tissue discrepancy in Möbius sequence: Clinical report and review of the literature

Raquel Guijarro-Martínez<sup>a,\*</sup>, Federico Hernández-Alfaro<sup>a,b</sup><sup>a</sup> Institute of Maxillofacial Surgery and Implantology (Head: Prof. Dr. Federico Hernández-Alfaro; Fellow: Raquel Guijarro-Martínez), Teknon Medical Center, Vilana, 12, D-185, 08022 Barcelona, Spain<sup>b</sup> Clinical Professor in Oral and Maxillofacial Surgery, Director, Master in Implant Dentistry, Universitat Internacional de Catalunya, Barcelona, Spain

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## ABSTRACT

**Background:** Möbius sequence implies significant maxillofacial hard and soft tissue anomalies which nevertheless have not been addressed thoroughly in the scientific literature.**Objectives:** To report a case of complete Möbius sequence and discuss the management of maxillofacial hard and soft tissue anomalies.**Patients and methods:** A 15-year-old girl with complete Möbius underwent bimaxillary orthognathic surgery, horizontal sliding genioplasty and mentalis muscles reinsertion. Vestibuloplasty and bilateral canthopexy were performed to address lip deficiency and attenuate hypotonic depression of the lower eyelids, respectively. Cheekbone augmentation was achieved with an autologous fat transfer. The authors review the scientific literature and discuss surgical planning for the correction of maxillofacial discrepancy.**Results:** The patient exhibits significant functional and aesthetic improvement, with excellent integration of the transferred fat and adequate bone healing.**Conclusions:** Orthognathic bimaxillary surgery combined to soft tissue management can improve aesthetics and orofacial function in Möbius patients, thereby contributing to facilitate social interaction and increase patients' self-esteem.

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## 1. Introduction

The constellation of anomalies we currently call "Möbius sequence" was first described by Albrecht Von Graefe in 1880 (Von Graefe and Saemisi, 1880). In 1888, the German neurologist Paul Julius Möbius reported more cases and reviewed its features. He defined the condition as a non-progressive congenital syndrome characterised by unilateral or bilateral peripheral palsy of the facial (VII) and abducens (VI) cranial nerves (Möbius, 1888). Although various authors use different diagnostic criteria, these are the most common chief findings (Strömland et al., 2002). Involvement of other cranial nerves, most often the glossopharyngeal (IX) and hypoglossal (XII), may also occur. Association with craniofacial and limb malformations as well as hypoplasia of the pectoralis minor (Poland anomaly) and autism can coexist (Sjögreen et al., 2001; Strömland et al., 2002). Although mental retardation has been reported in 10–15% of affected individuals (Scarpelli et al., 2008),

a recent Dutch study found no differences in intelligence quotient or attention and memory capacities between Möbius patients and healthy individuals (Verzijl et al., 2005).

The aetiology of the condition remains unclear. Various genetic and environmental factors have been studied. Several studies indicate transient foetal ischaemia in the territory of the primitive trigeminal, basilar and or vertebral arteries may impair the development of cranial nerve nuclei (Bavinck and Weaver, 1986; Strömland et al., 2002). The role of rhombencephalic maldevelopment involving predominantly motor nuclei and axons as well as traversing long tracts has also been pointed out (Verzijl et al., 2003). In any case, the term "Möbius sequence" is preferable to "Möbius syndrome" because a sequence implies multiple aetiologies whereas a syndrome entails one single cause.

Although it is considered a rare condition by various authors (Strömland et al., 2002; Verzijl et al., 2003; Sensat, 2003), the global incidence and prevalence remain undetermined. Males and females seem to be affected equally (Gorlin et al., 1990). Most cases occur sporadically, but family series with occasional karyotypic changes have been communicated (Ziter et al., 1977; Mitter and Chudley, 1983; Gorlin et al., 1990; MacDermot et al., 1991; Kremer et al.,

\* Corresponding author.

E-mail address: raquelguijarro@comv.es (R. Guijarro-Martínez).

1996; Verzijl et al., 2003). The number of reported cases has increased noticeably in the last years, possibly due to the widespread use of misoprostol, whose teratogenic role in the aetiopathogenesis of Möbius sequence has been confirmed (Gonzalez et al., 1993; Dal Pizzol et al., 2006; Magalhaes et al., 2006; Lima et al., 2009).

Möbius sequence is comprised within the oromandibular-limb hypogenesis syndrome grouped by Hall and Gorlin et al. This cluster is characterised by cranial nerve palsies, craniofacial anomalies (including micrognathia, cleft palate, anomalies of the tongue, teeth and ears) and limb abnormalities (such as syndactyly, clubfeet, ectrodactyly and even amputation-type defects), with or without Poland anomaly (Hall, 1971; Gorlin et al., 1990).

In the cranio-maxillofacial region, complete or partial facial paralysis leads to impaired facial expression with a characteristic mask-like appearance and limited social interaction. Many patients develop alternative ways of effective communication such as an expressive voice, corporal language or verbal communication (Sjögreen et al., 2001). In a similar way, compensatory articulation helps replace the labial sounds, which are the most affected by facial palsy.

Characteristically, involvement of the mimic muscles causes oral incompetence with a hypotonic–hypoplastic upper lip and drooping mouth angle. This in turn results in secondary drooling, angular cheilitis and dysarthria (Scarpelli et al., 2008; Lima et al., 2009; Bianchi et al., 2009). Feeding problems are common, especially in childhood. These are aggravated by the common coexistence of micrognathia and microstomia.

Ocular manifestations include inability to close the eyelids and restricted lateral movements. Most patients do not have strabismus when looking straight-ahead, but they tend to turn their head to compensate for the limitation of movement horizontally (Strömland et al., 2002). Ptosis, nystagmus, conjunctivitis and abnormal lacrimation may be present too (Karoluk and Lanigan, 1989; Strömland et al., 2002; Sensat, 2003).

Intraoral examination may reveal dental caries and gingivitis, teeth hypoplasia or agenesis, a small asymmetric tongue with

irregular atrophic areas, gothic or cleft palate and bifid uvula (Kumar, 1990; Sjögreen et al., 2001; Serpa-Pinto et al., 2002; Magalhaes et al., 2006; Lima et al., 2009). Tongue atrophy, impaired motility and fasciculations can be present as a result of hypoglossal nerve involvement. Severe dysphagia and velopharyngeal insufficiency suggest affection of the glossopharyngeus and vagus nerves (Strömland et al., 2002). As a result of hypofunction of the perioral musculature and tongue, oral hygiene is often difficult, thereby raising the risk of dental caries.

Malocclusion is a frequent finding in patients with Möbius sequence and related disorders. Patients tend to exhibit maxillary constriction with increased overjet and anterior open bite. Mouth opening is often restricted due to the size of the oral cavity and lack of muscle elasticity (Scarpelli et al., 2008). Protrusion and lateral excursions of the mandible may be limited too.

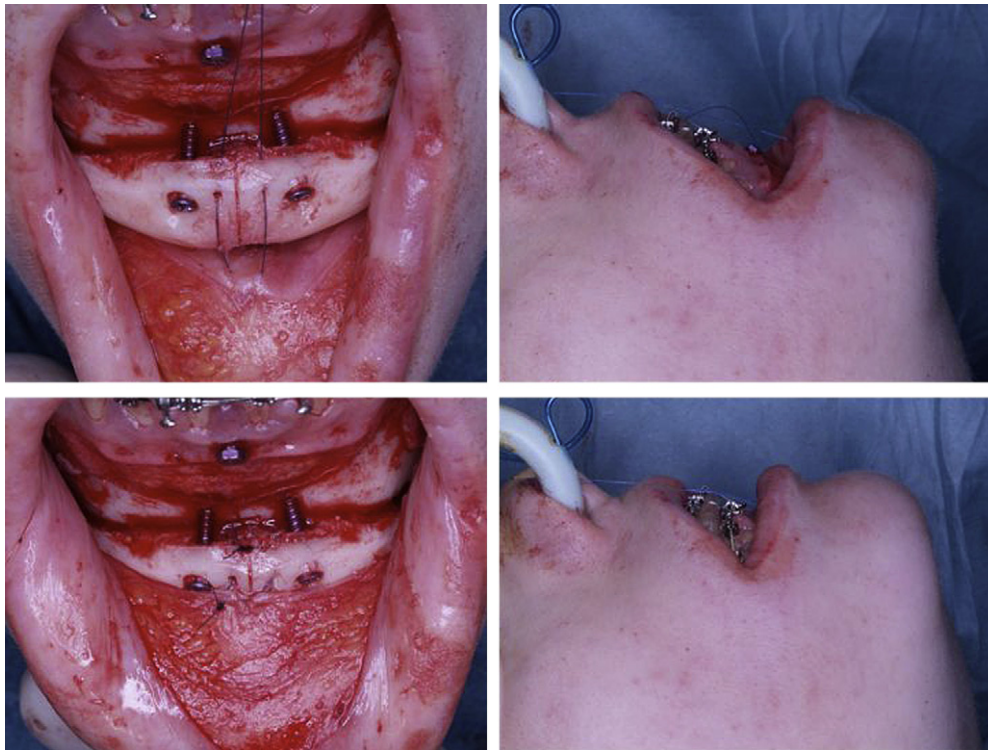
Optimal surgical treatment for individuals with Möbius sequence is still under discussion. The scarceness of experienced professionals and rareness of the condition often leads to delayed diagnosis and deferred or incorrect treatment. Regarding facial paralysis, microneurovascular transfer of a free-muscle transplant is currently the procedure of choice. The gracilis muscle represents the first option for facial animation due to easy access, dispensability and suitable vasculature (Ueda et al., 1998; Zuker et al., 2000; Bianchi et al., 2009). However, the issue of malocclusion and facial disproportion has only been addressed anecdotically in the scientific literature (Chou et al., 2010). The purpose of this article is hence to report a case of complete Möbius with which to exemplify the management of orofacial hard and soft tissue discrepancies.

## 2. Case report

A 15-year old girl was referred by her orthodontist for evaluation of surgical correction of her malocclusion. Her medical history was significant for Möbius sequence and she was under medical,



**Fig. 1.** Preoperative facial appearance: complete bilateral facial paralysis. Preoperative intraoral examination: Angle class II with anterior open bite. Poor hygiene and generalised gingivitis.



**Fig. 2.** Left: mentalis muscles reinsertion at the edge of the genioplasty osteotomy. Right: external appearance of the chin line before and after repositioning of mentalis muscles.

speech and physical treatment. There was no other affected individual in the family, and the mother reported an uneventful pregnancy and delivery.

On clinical examination, the patient presented a complete Möbius (complete bilateral facial and abducens nerve paralysis) according to the terminology proposed by Terzis and Noah (2002). No associated craniofacial, limb or chest wall anomalies were present. There was no mental retardation or cognitive capacity restriction. Frontal inspection revealed epicanthus, inferior scleral show and depression retraction of the lower eyelid due to hypotonia. The upper lip was foreshortened with no effective lower lip support, causing secondary oral incompetence with drooling and anterior tooth exposure. Interlabial gap at rest was 25 mm. Commissural movement and bilabial coordination for speech and emotional expression were totally absent. Regarding facial proportion analysis, the lower facial third was elongated. Profile evaluation revealed flat cheekbones, normal nasal projection, absent upper lip support, retruded soft tissue pogonion and no chin line (Fig. 1).

On intraoral inspection, a normal dentition and hypotrophic tongue (with no deformities or ankyloglossia) were observed. Vestibular depth was significantly reduced in the upper and lower lip as a result of hypotonia and hypotrophy of the orbicularis oris muscle. Oral hygiene was poor and generalised gingivitis was present. Dentoskeletal analysis revealed an anterior open bite with Angle class II molar and canine relation. There was no transversal discrepancy.

After 17 months of orthodontic preparation, the patient underwent orthognathic surgery under general anaesthesia. A Le Fort I maxillary osteotomy was designed in order to impact 10 mm at the incisors and 5 mm at the first molars. Bilateral sagittal split osteotomies (BSSO) were performed for a mandibular advancement of 7 mm. Significant counterclockwise rotation of the maxillomandibular complex was achieved. Together with a horizontal

sliding genioplasty with advancement of the mandibular symphysis, this allowed for the correction of anteroposterior chin deficiency and helped define the chin–neck contour. Mobilised segments were stabilised with titanium miniplates, 4 in the maxilla and 2 in the mandible. Genioplasty was fixed with two lag screws. Mentalis muscles were reinserted at the edge of the osteotomy in order to maintain soft tissue support as much as possible (Fig. 2). Upper and lower lip deficiency was addressed with a vestibuloplasty.

The surgical plan included bilateral canthopexy to attenuate the hypotonic depression of the lower eyelids and soft tissue augmentation in the cheekbone area. For the latter, an autologous fat transfer was performed. Due to its ease of access and availability, the selected donor sites were the trochanteric areas. Moderate overcorrection was performed. Fig. 3 shows immediate postoperative results.



**Fig. 3.** Immediate postoperative results. At the back, initial profile.





Fig. 4. Postoperative facial appearance after 5 months. Zygomatic soft tissue augmentation and new chin line.

Five months after surgery, the patient exhibited significant functional and morphological improvement (Figs. 4–5). Excellent integration of the transferred fat is observed in the recipient sites. Control imaging studies reveal adequate bone healing and excellent stability of the osteotomies.

### 3. Discussion

Möbius sequence implies numerous and substantial manifestations in the cranio-maxillofacial region. The prevalence of these anomalies among Möbius patients has been estimated around 90% (Verzijl et al., 2003). However, few articles addressing cranio-maxillofacial dysfunction in Möbius sequence exist in the scientific literature. The spectrum of involvement can vary from slight unilateral facial weakness to complete paralysis of various cranial nerves with multiple associated anomalies. The patient described here had complete bilateral facial and abducens nerve paralysis causing a distinctive mask-like appearance and severe restriction in communicative abilities. In truth, maxillofacial problems have a significant impact on patients' and their families' quality of life. The combination of feeding problems, difficulties in verbal communication and inability to show happiness, sadness or anger frequently lead to severe introversion and low self-esteem.

The broad spectrum of cranio-maxillofacial signs and symptoms in Möbius patients calls for a multidisciplinary approach. Facial palsy management with microvascular free-muscle transfer has been widely addressed in the scientific literature (Johnson et al., 1997; Ueda et al., 1998; Zuker et al., 2000; Goldberg et al., 2003; Bae et al., 2006; Bianchi et al., 2009). The issues of increased risk of periodontal disease and dental caries have been considered previously too (Serpa-Pinto et al., 2002; Sensat, 2003; Magalhaes et al., 2006; Scarpelli et al., 2008; Lima et al., 2009). However, to our knowledge, the problem of malocclusion has only been mentioned once in the scientific literature (Chou et al., 2010). Similarly, facial soft tissue management in these patients has seldom been considered (Sabbagh et al., 2003; Lindsay et al., 2010). This is surprising considering the substantial impact of orthognathic surgery and additional aesthetic procedures in patients' orofacial function, morphology, social interaction and, ultimately, self-esteem.

Dental treatment encounters a number of difficulties due to the characteristic limitations of the Möbius condition. As it occurred in our patient, oral hygiene is often poor as a result of hypomobility of the masticatory muscles and tongue. Food retention in the oral



Fig. 5. Postoperative oral and occlusal appearance after 5 months. Lip elongation after upper and lower vestibuloplasties. Adequate stability of the osteotomies.

cavity is prolonged by deficient oral hygiene and compromised mastication and deglutition. Moreover, the need to ingest a soft diet, especially if complete bilateral facial palsy exists, further increases the risk of dental caries. Dental treatment in paediatric patients comes across additional difficulties such as the small inelastic stoma, dry lip mucosa and angular cheilitis. Furthermore, uncooperative behaviour is common, especially if autism coexists. Therefore, the dental plan for Möbius patients must be developed in agreement with the families or guardians in order to take into consideration the specific limitations of the patient together with particular dental needs (Scarpelli et al., 2008).

Regarding facial palsy in general, temporalis muscle transposition is a reliable and highly versatile option (Clauser et al., 1995). It should be considered when crossover facial nerve reinnervation or grafting is not possible. However, ectopic bone formation in Möbius patients, in particular after muscular neurotization, has been reported (Franz et al., 2007).

Currently, microneurovascular transfer of a free-muscle transplant is the gold standard treatment. The gracilis muscle is probably the most advantageous option due to easy access, dispensability and appropriate vasculature for free transfer (Johnson et al., 1997; Ueda et al., 1998; Zuker et al., 2000; Bianchi et al., 2009). Meticulous surgical planning is necessary in order to minimise asymmetric movement and excessive bulk at the site of the transplant (Bae et al., 2006). The contralateral facial nerve provides the preferred innervation for the muscle transfer in unilateral facial palsy (Zuker et al., 2000; Bae et al., 2006). In bilateral forms, the motor nerve to the masseter muscle is a good alternative. In any case, postoperative smile training is essential in order to achieve a spontaneous and symmetrical smile (Bianchi et al., 2009).

Hard tissue discrepancy must always be addressed prior to facial palsy management. Sagittal discrepancy is common in Möbius patients, often associated with vertical anomalies. Anterior open bite with clockwise rotation of the mandible is frequently noted, as in our patient. In cases of hypoglossal nerve involvement, it is possible that tongue paralysis and anteroinferior lingual position alter intraoral pressures and play a role in the development of maxillary constriction and hence posterior cross-bite. Our patient had no transverse discrepancy. Bimaxillary surgery was performed to reduce the vertical dimension, advance the mandible and correct the clockwise rotation of the occlusal plane. It is important to point out significant forward movements and/or counterclockwise rotations require the reinsertion of mentalis muscles in order to maintain soft tissue volume and support.

Lip elongation procedures must be considered in order to correct labial deficiency. In our patient, vestibuloplasties were performed to increase vestibular depth in the maxilla and mandible. The combination of a dermal graft and full-thickness skin graft may also be used to address a foreshortened upper lip in Möbius patients. The dermal graft increases the fullness of the upper lip and the skin graft lengthens the vestibule. According to the authors, this technique potentially improves aesthetics and speech (Lindsay et al., 2010).

Patients may benefit from additional aesthetic procedures such as canthopexy or fat grafting in order to correct the hypotonic depression of the lower eyelids and volumetric deficiency at the zygomatic area, respectively. The popularity of autologous fat grafting for facial soft tissue augmentation has notably increased among Cranio-Maxillofacial surgeons during the last 20 years. No significant differences in fat viability have been detected when comparing different donor sites (Rohrich et al., 2004). In our patient, we chose the trochanteric areas for ease of access, safety and availability. According to Coleman's technique, fat must be centrifuged prior to injection (Coleman, 2006). However, there are no significant differences in adipocyte viability between centrifuged and non-

centrifuged fat (Rohrich et al., 2004). In our patient, fat was infiltrated through multiple passes after a short period of sedimentation and supernatant removal. Moderate overcorrection was performed to make up for the volumetric decrease that tends to occur during the first 4–6 postoperative months. After that, graft volume has remained stable and the patient is highly satisfied with the result.

#### 4. Conclusions

Möbius sequence entails significant maxillofacial hard and soft tissue discrepancies which require proficient surgical planning and often call for a multidisciplinary approach. The authors present a case of complete Möbius sequence where orthognathic bimaxillary surgery combined to soft tissue management significantly contributed to improve aesthetics and orofacial function.

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None.

#### Conflict of interest

The authors declare no conflicts of interest.

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