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# CASE REPORTS

# MOEBIUS SYNDROME - IMPROVING OUTCOME WITH COMBINED STATE-OF-THE-ART SURGICAL AND REHABILITATION TREATMENTS

## SÍNDROME DE MOEBIUS – MELHORAR O PROGNÓSTICO COM TRATAMENTOS CIRÚRGICOS E DE REABILITAÇÃO DE PONTA

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## ABSTRACT

Moebius Syndrome (MBS) is a rare disorder, characterized by congenital, non-progressive facial palsy and other cranial and limb defects. A typical “mask-like” appearance, drooling, and indistinct speech comprise the dominant features.

Treatment focuses on correcting deformities and enhancing functionality. Surgical free functional muscle transfer (FFMT) is the gold standard for facial reanimation. A comprehensive rehabilitation program addressing motor, cognitive, and social impairment is paramount, despite the scarcity of knowledge regarding MBS rehabilitation, especially concerning central nervous system reorganization.

A six-year-old boy with MBS received treatment in our Department since the age of four months, including speech, physical, and occupational therapy. Recently, he underwent facial reanimation surgery.

The authors believe that rehabilitation improved the patient’s outcome by enhancing cortical representation before and neuroplasticity after surgery. Coordination of both interventions seems pivotal to fully address MBS.

**Keywords:** facial paralysis; Moebius syndrome, occupational therapy, physiatry, physical therapy, rehabilitation, speech therapy

## RESUMO

A síndrome de Moebius (MBS) é rara e caracteriza-se por paralisia facial e outros defeitos congénitos não-progressivos do crânio e membros. O fácies inexpressivo, a sialorreia abundante e o discurso ininteligível constituem as características dominantes.

O tratamento visa corrigir deformidades e otimizar a função. A transferência de enxerto muscular funcional (FFMT) é o *gold standard* na cirurgia de reanimação facial. Um programa de reabilitação abrangente dirigido às limitações motoras, cognitivas e funcionais também é fundamental, apesar da escassez de conhecimento acerca da reabilitação na MBS, sobretudo no que diz respeito à reorganização do sistema nervoso central.

Um rapaz de seis anos com MBS recebeu tratamento no nosso Departamento desde os quatro meses, incluindo terapia da fala, fisioterapia e terapia ocupacional. Recentemente, foi submetido a cirurgia de reanimação facial noutra instituição.

Os autores acreditam que a reabilitação melhorou o resultado final, ao potenciar a representação cortical antes e a neuroplasticidade após a cirurgia. A coordenação entre ambas as intervenções parece essencial para o tratamento holístico do MBS.

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**Palavras-chave:** fisiatria, fisioterapia, paralisia facial, reabilitação, síndrome de Moebius, terapia da fala, terapia ocupacional

## INTRODUCTION

Moebius syndrome (MBS) was first described by Paul Moebius in 1892 and is characterized by the association between facial palsy and other cranial and limb deformities.[1,2] Prevalence is estimated to be 1/50.000 to 1/500.000 live births, with equal incidence in both sexes.[3]

Initially thought to be a sporadic disorder associated with *in utero* events, recent gene (PLXND1 and REV3L) discoveries highlighted a cause for familial cases and reports demonstrated an autosomal and X-linked inheritance.[4-6]

Minimum diagnostic criteria are "*congenital, non-progressive, bilateral or unilateral, symmetrical or asymmetrical facial and abducens nerve palsies, in the presence of full vertical gaze*".[5] The typical "mask-like" face of MBS patients leads to impaired non-verbal communication that, together with drooling and indistinct speech, are the dominant features of this heterogeneous syndrome.[4] Evaluation by a geneticist is important whenever a different diagnosis is suspected and to predict risk for future offspring.[5]

Treatment focuses on correcting deformities and enhancing functionality. Advances in microsurgical techniques have made surgical free functional muscle transfer (FFMT) the gold standard for treating long-standing facial paralysis.[7] A rehabilitation program addressing motor, cognitive, and social impairment is paramount. Interventions can aim to improve feeding, swallowing, saliva management, facial movement, speech intelligibility, social skills, and communication quality. The combination of surgery and rehabilitation is likely to improve clinical and functional outcomes. New surgical techniques, such as nerve-graft muscle anastomoses, have introduced new neural pathways contributing to the expansion of neuro-rehabilitative approaches by means of exploiting brain plasticity. Findings that motor cortex participates in sensory information processing challenged the classic view of movement circuitry and gave support to the use of sensory stimulation techniques in therapy.[8] The same occurred with mirror neuron system (MNS) findings, which have contributed to explain learning of motor patterns through observation and imitation, also empirically included in many rehabilitation techniques.[3] There is however a paucity of knowledge regarding the role of rehabilitation specifically in MBS patients and particularly regarding central nervous system (CNS) reorganization. The present case report aims to draw attention to the pivotal role of an integrated and comprehensive rehabilitation program for MBS patients.

## CASE REPORT

A three-month-old male infant was referred to our consultation presenting asymmetrical facial paralysis, convergent strabismus with vertical gaze sparing, axial hypotony, *pes adductus*, and difficulties in food ingestion, noted soon after birth. Cerebral magnetic resonance imaging (MRI) revealed agenesis of bilateral facial and left abducens nuclei (CN IX, X, and XI were visible in their route towards the jugular foramen), confirming MB diagnosis. The patient started a rehabilitation program with physical, speech, and occupational therapy one month later. Initial observations revealed low yield suction due to incomplete mouth closure, asymmetrical tongue elevation, and left cheek hypotony. Speech therapy (ST) was initially planned to treat dysphagia (soup and minced fruit were introduced at the age of five months), with improvement in suction and swallowing coordination, food acceptance and retainment, and saliva/water swallowing as initial goals. Simultaneously, social interaction, turn-taking, initiative, and communicative intention were also worked upon. Later, vocalization and communicative action/context pairing were improved. Growing up, the boy revealed slight developmental delay – head control at six months, fine manipulation at nine months, supported sitting at 12 months, and walking at 20 months. Around the age of 20 months, he produced his first rudimental words, steering rehabilitation towards language and speech training, while promoting compensatory strategies for dysphagia (volume and consistency management). Taping and proprioceptive neuromuscular facilitation (PNF) were added to increase afferent stimuli and enhance cortical representation. Rehabilitation continued on a weekly, one-hour intervention basis. During this time, the patient underwent several surgeries: correction of pyloric stenosis (4 months); eye occlusion inability (18 months); tonsillectomy, adenoidectomy, and tympanic ventilation tube insertion (22 months). At four years old, he was proposed for reanimation surgery at a foreign institution. By that time, he no longer presented any significant appendicular or axial motor deficit, language delay, or dysphagia, but kept a significant articulation disorder. On verbal articulation test (VAT)[9], he was unable to produce bilabial consonants and depended on cueing to perform sibilant phonemes, except for fricatives, which were also unattainable. Speech intelligibility, assessed during a three-minute interview, was below 30% (speech rate near normal for age). Saliva pooling and dripping were significant. He scored 17 [15-32-0] on the *Sunnybrook Facial Grading System* (FGS).

The patient underwent a two-stage surgical intervention: cross-facial nerve grafting from the right facial nerve (using right sural nerve) at 4.5 years; and gracilis FFMT, with double innervation (from cross-facial nerve graft and from the masseteric branch of the left trigeminal nerve) nine months later. On the third week post-surgery, an intensive, supervised, inpatient rehabilitation protocol for facial activation was started, which according to the patient's mother consisted of *smiling* paired with masseteric muscle activation (bite) and electrical neuromuscular stimulation of the left side. Despite absence of guidelines regarding electrical stimulation therapy parameters in children, the literature has shown safety and efficacy of this intervention in muscle mass improvement and strength.[10] On the 42nd day, first active movements were noted. Maximal range of motion (ROM) was achieved on the 75th day, after which the boy was discharged and resumed treatment at our hospital. He presented with full-amplitude labial movement, significant saliva control improvement, and smile symmetry. Three months later, he was able to smile independently of biting.

Presently, after 36 sessions, speech intelligibility is above 50%. The patient displays good saliva control with little need of reminder and is able to correctly perform both sibilant and bilabial phonemes, the latter (as with fricatives) needing only occasional cueing. He scores 33 [15-48-0] on FGS, with notable improvement in *symmetry of voluntary movement*. No pain or mastication difficulties were noted during rehabilitation. He was enrolled in school and seems perfectly integrated.

## DISCUSSION

MBS is a rare cause of facial palsy. Patients typically have a “mask-like” appearance that may impact social interaction and personality development. Despite usually normal intelligence, motor, emotional, and language development delay is frequent.[6-11] This means that, even when achieving normal development (as 90% seem to do at the age of five), the complexity of care and lack of emotion recognition may affect the child’s relationships. Although this may support the need for early surgical intervention, it also highlights the importance of prompt rehabilitation, aiming to enhance family awareness, functional status and child participation, and post-surgical acquisitions. The present patient started ST early in life to ameliorate feeding and communication impairment. Strengthening and fine motor control of cheeks, lips, and velopharyngeal valve benefited feeding and communication. Compensatory mechanisms, such as labio-dental approximation and jaw protrusion, have improved bilabial tasks, like lip closure, saliva control, and intelligibility.

Surgical treatment aims to restore volitional facial movement and correct associated malformations.[4] Gracilis FFMT has become widely accepted as the best option, due to ease of access, size, single neuron innervations, and low morbidity to donor site.[2,7] Due to MBS heterogeneity, choice of donor nerve is not consensual and should be preceded by thorough neurological, neurophysiologic, and imaging assessment. In the present case, the surgeons opted to use both contralateral facial (for more synchronous and spontaneous smile) and ipsilateral masseteric nerve (for optimal and rapid reinnervation). Follow-up of patients treated using this approach has shown adequate commissure excursion, oral competence, and improved speech, but reports of fat infiltration and atrophy and fibrosis of the muscle transplant have been described and associated with long-term functional decline.[12]

Patients must start rehabilitation soon after surgery. Fairgray and Miles reported the case of a patient that presented the first signs of improvement only after beginning ST, 11 months later.[13] Great functional improvements with rehabilitation may be related both to stimulation of available functional structures and post-surgical neuroplasticity phenomena. This process has been defined as the “ability of the human brain to reorganize its functional organization in response to environmental stimuli”.[6] Several studies have demonstrated cortical reorganization after injury and repair of different body segments.[14] This reorganization is achieved through repetitive, intense, and goal-oriented movement – cortical activation is higher with purposeful movements.[15] Two other features of brain function and organization may also play a very important role in MBS rehabilitation. First, the fact that cortical representation of the mouth and hand overlap each other; second, the existence of MNS that facilitates cortical and muscle activation, whether one is doing or just observing a purposeful movement.[15,16] Based on these concepts, Ferrari *et al* designed a protocol proposing *Synergistic Activity Therapy* (SAT) and *Facial Imitation Therapy* (FIT).[3] SAT works through simultaneous smiling and clenching of the hand. For the authors, clenching the hand should facilitate recruitment of mouth motor programs for smiling, due to cortical overlap areas. Synergistic hand-mouth movements in human activity are well described across the literature, making sense that these might be closely represented at a cortical level. On the other hand, FIT uses visual information to activate MNS and facilitate the same programs. When a video of a person smiling for three seconds is shown to healthy subjects, facial expression visualization activates a mirror circuitry and action-related areas involving the inferior frontal gyrus, premotor cortex, and parietal lobe leading to smile imitation. This drove the hypothesis that smile observation could improve smile recovery in MBS patients.[3] Indeed, this patient’s attempt to move the lips was facilitated by the synchronous observation of a smile performed by another individual. Preliminary results for this protocol are encouraging and reports that some patients submitted to FFMT could independently and voluntarily activate the muscle graft have highlighted the role of neuronal plasticity in MBS neurorehabilitation.[6] In the present case, dysphagia, saliva control, and speech articulation therapy was proposed when surgery had not yet been considered. We strongly believe that presurgical rehabilitation program later contributed to better surgical outcomes, by enhancing cortical representation of the structures worked upon through stimulation of sensory pathways and, probably, MNS activation. Furthermore, incomplete palsy of the right side may have enabled construction of neural circuitry and motor programming of different movements that would subsequently more easily “transfer” to the contra-lateral hemisphere, possibly aided by MNS as well. On this matter, Marre and Hontanilla reported the case of a child with bilateral facial palsy who developed spontaneous movement of the commissural musculature on one side after gracilis FFMT to the contra-lateral side and intensive therapy.[6]

Whatever the method, intensive training of a behaviorally relevant task and a "plastic" younger brain appear to be determinant to succeed. It is believed that patients should maintain rehabilitation treatment for a minimum period of 30 months to enhance cortical adaptation of smile, after which may proceed to home-based rehabilitation, with periodic consultation.[2] Although we are not against this recommendation, we feel it falls short of what should be a more ambitious, comprehensive, and continuous intervention within a rehabilitation program including speech, physical, and occupational therapy.

## CONCLUSION

Promising advances in surgical and rehabilitation field have enabled great improvements in MBS patients' quality of life. The combination of specialized surgical and rehabilitation care together with good family support are crucial to improve patients' prognosis. This study presented the case of a child who benefited from both surgical and medical interventions, despite absence of a formal coordination between both. Although such coordination is desirable to further enhance results, the authors highlight the importance of multi-professional and integrated therapeutic programs to better suit patients' functional and holistic outcomes.

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