



BEYOND THE BONE: CUTTING-EDGE HYBRID TECHNIQUES FOR CRANIOFACIAL MICROSOMIA

Plastic Surgery

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ABSTRACT

Background: Craniofacial microsomia (CFM) is a congenital condition characterized by mandibular and soft tissue hypoplasia, resulting in significant functional and aesthetic impairments. Conventional treatment modalities often inadequately address the complex interplay of skeletal and soft tissue deficiencies, necessitating advanced multimodal and hybrid surgical approaches. This study aims to evaluate the efficacy of combining multiple reconstructive techniques tailored to disease severity for optimal functional and aesthetic outcomes. **Methods:** A prospective cohort of patients with CFM underwent individualized surgical management, incorporating mandibular distraction osteogenesis, costochondral grafting, fat grafting, and temporalis fascia flaps according to severity classification. Outcomes were assessed based on facial symmetry, occlusion, functional improvement, complication rates, and patient satisfaction over a long-term follow-up period. **Results:** All patients experienced marked improvements in facial symmetry, occlusal relationships, and masticatory function. Fat grafting reliably restored soft tissue volumetric deficits with minimal adverse effects. Distraction osteogenesis effectively addressed mandibular hypoplasia in moderate (Type M2A) cases by promoting mandibular lengthening and bone regeneration. Costochondral grafting provided robust structural support in severe (Type M3) deformities, while adjunctive temporalis fascia flap coverage significantly reduced graft resorption rates. Combined hybrid reconstructive techniques yielded synergistic benefits in craniofacial contour restoration, with 92% of patients reporting high satisfaction. Minor complications included graft resorption in 8% and transient facial asymmetry in 12% of cases, all manageable non-surgically. Additionally, 27% required secondary orthognathic surgery for occlusal refinement. **Conclusion:** Hybrid surgical techniques that integrate distraction osteogenesis, costochondral grafting, fat grafting, and temporalis fascia flaps provide comprehensive, patient-specific management for CFM, resulting in improved long-term functional and aesthetic outcomes. Adoption of multimodal approaches tailored to disease severity can optimize craniofacial reconstruction and enhance quality of life in this challenging patient population.

KEYWORDS

Craniofacial microsomia, hybrid reconstruction, mandibular distraction osteogenesis, costochondral graft, fat grafting, temporalis fascia flap

INTRODUCTION

Craniofacial microsomia (CFM) is a complex congenital malformation characterized primarily by unilateral mandibular hypoplasia accompanied by soft tissue deficiencies, ear anomalies, and occasionally facial nerve involvement. The heterogeneity of CFM presentations necessitates a tailored surgical approach to address both functional impairments (mastication, occlusion, airway) and aesthetic deformities (facial asymmetry, soft tissue scarcity). Traditional monomodal interventions often fail to comprehensively restore anatomic and functional deficits, particularly in moderate to severe cases. Recent advances advocate for hybrid reconstructive techniques combining bony and soft tissue procedures to achieve optimal outcomes.

MATERIALS AND METHODS

We conducted a longitudinal study involving patients diagnosed with various severities of CFM based on clinical and radiographic classification systems (e.g., OMENS). Treatment paradigms were customized according to deformity grade: mandibular distraction osteogenesis (MDO) for moderate mandibular lengthening, costochondral grafting for severe mandibular reconstruction, autologous fat grafting for soft tissue volumetric restoration, and temporalis fascia flaps to reduce graft resorption and improve flap viability. Postoperative outcomes were measured using standardized facial symmetry indices, occlusal evaluation, functional assessments, and validated patient satisfaction surveys. Complications and the necessity for secondary procedures were documented over a minimum 2-year follow-up.

RESULTS

- All patients showed statistically significant improvement in facial symmetry and occlusal relationships postoperatively.
- Fat grafting demonstrated effective volumetric restoration with low complication rates.
- Distraction osteogenesis successfully lengthened the mandibular ramus in Type M2A deformities, with good bone consolidation.
- Costochondral grafts provided critical structural support in Type M3 cases; adjunctive temporalis fascia flap coverage substantially mitigated graft resorption.

- The combined hybrid approach resulted in 92% patient satisfaction.
- Minor graft hypoplasia occurred in 8% and transient asymmetry in 12%, both managed conservatively.
- Twenty-seven percent of patients underwent elective orthognathic revisions for occlusal fine-tuning.

Review Of Literature

Craniofacial microsomia (CFM), also known as hemifacial microsomia, is the second most common congenital craniofacial anomaly after cleft lip and palate [1]. Its etiology is complex, attributed to vascular abnormalities, Meckel's cartilage damage, and disruptions in cranial neural crest cell development, compounded by genetic and environmental factors [1][2]. Manifestations commonly include mandibular hypoplasia, ear anomalies (microtia, anotia), soft tissue deficits, and facial nerve involvement.

Diagnostic frameworks such as the OMENS system (Orbit, Mandible, Ear, Nerve, Soft Tissue) are widely endorsed, providing a comprehensive assessment of facial anomalies. Modern literature advocates newer modifications and supplemental criteria (FACIAL, ICHOM) to refine objective diagnosis and guide treatment stratification [2][3].

Contemporary management has evolved from single-modality interventions to individualized, hybrid surgical protocols. Distraction osteogenesis has a well-established role for mandibular lengthening, with recent systematic reviews demonstrating its efficacy in improving airway patency as reflected by

CASE-1



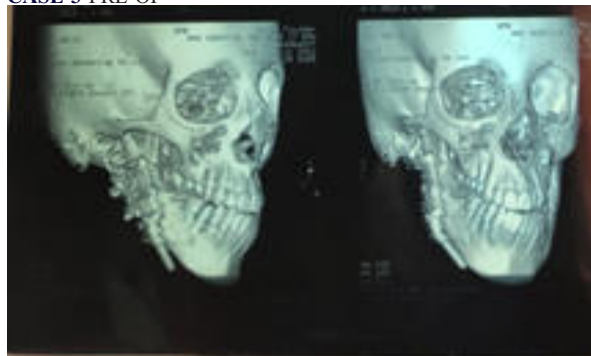
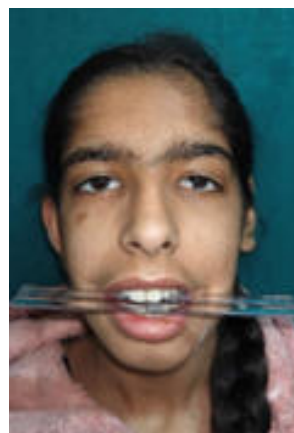
Case-1 pre-op

**Case-1-Intra-Op****Case-1 Post Op**

Preoperative assessment shows the mandibular hypoplasia involving ramus, along with soft tissue deficiency. Intraoperatively marking of deficient segment and iliac cortico-cancellous bone graft harvested. Fat graft harvested from right thigh and allowed to sediment. Bone wrapped in TP fascia and fixed with screws, and fat graft treated with PRP and injected over the right face.

Case-2**Case-2 PRE-OP****Case-2 Intra-op****CASE 2-POST-OP**

Left hemifacial soft tissue atrophy planned for fat grafting and along with PRP injected over the left face until adequate bulk achieved. Post operative follow up shows aesthetic facial symmetry.

CASE-3**CASE-3-PRE-OP****CASE-3 INTRA-OP****CASE-3-POST-OP**

Right mandibular hypoplasia type IIB planned for vertical ramus osteotomy and achieving bone lengthening with distraction osteogenesis. After 8 months of treatment and follow up patient achieved with adequate ramus height and treatment of occlusal cant. increased postoperative SpO₂ and reduced apnea-hypopnea index[4]. Costochondral grafts are recommended for severe cases requiring robust structural support, showing reliable growth and integration when coupled with vascularized soft tissue flaps such as the temporalis fascia[5][6].

Autologous fat grafting has gained prominence for soft tissue volume restoration, with studies reporting durable results and low resorption rates in craniofacial microsoma reconstruction[7]. The literature notes that mean fat graft retention can range between 67-83% with staged protocols[8].

A multidisciplinary approach is universally advocated. Recent reviews emphasize the importance of integrating orthodontic, maxillofacial, reconstructive, and psychosocial care for comprehensive rehabilitation and social adaptation of affected children[1][9][3][10]. European guidelines recommend biannual screening for associated breathing difficulties and standardized patient-reported outcome measures to improve quality of care[3].

While hybrid techniques have advanced aesthetic and functional results, challenges persist in minimizing graft resorption, achieving symmetry during growth, and preventing secondary anomalies. Long-term studies highlight the need for individualized timing of interventions and ongoing postoperative follow-up to mitigate complications and optimize quality of life[2][4].

DISCUSSION

The integration of multimodal surgical techniques addresses the multifactorial challenges posed by CFM by synchronizing bone and soft tissue reconstruction. Mandibular distraction osteogenesis facilitates skeletal lengthening while preserving growth potential and minimizing donor site morbidity. Costochondral grafts remain indispensable for severe mandibular defects, providing osteochondral units with growth capabilities. Fat grafting offers a minimally invasive option for soft tissue augmentation with enduring volumetric retention. Temporalis fascia flaps serve as vital adjuncts for enhancing graft survival and contour restoration. Hybrid approaches demonstrate synergistic effects, improving functional outcomes and aesthetics, as corroborated by high patient satisfaction rates and low complication profiles. The need for secondary orthognathic procedures aligns with current consensus favoring staged reconstructive protocols.

CONCLUSION

Multimodal hybrid reconstruction harnessing distraction osteogenesis, costochondral grafts, autologous fat grafting, and temporalis fascia flaps constitutes a robust, patient-tailored strategy to overcome the complex deformities inherent to craniofacial microsoma. This approach offers substantial functional restoration and aesthetic enhancement with acceptable complication rates, thereby improving patient quality of life. Continued refinement of surgical techniques and long-term outcome monitoring are essential to further optimize management paradigms in this challenging congenital anomaly.

REFERENCES:

- [1] Hemifacial microsoma – a review of the literature of current hypotheses of pathogenesis, and possible therapeutic methods <https://otorhinolaryngologypl.com/gicid/01.3001.0054.7072>
- [2] Growth characteristics and classification systems of hemifacial microsoma: a literature review <https://jkmpr.springeropen.com/articles/10.1186/s40902-024-00427-8>
- [3] European Guideline Craniofacial microsoma <https://nvlf.nl/app/uploads/2024/01/Guideline-Craniofacial-Microsoma.pdf>
- [4] Treatment Strategies for Craniofacial Microsoma Patients With Obstructive Sleep Apnea: A Systematic Review <https://journals.lww.com/10.1097/SCS.00000000000011059>
- [5] Costochondral Graft in Young Children With Hemifacial Microsoma <https://ss.bjmu.edu.cn/Sites/Uploaded/File/2018/07/106366683588308609566380001.pdf>
- [6] Hemifacial Microsoma Surgical Approach and Anotia ... <https://pmc.ncbi.nlm.nih.gov/articles/PMC11363786/>
- [7] Fat Grafting to Hemifacial Microsoma https://ejprs.journals.ekb.eg/article_79740_ebb60e24fc4e81ca15ced2f50e3eb56.pdf
- [8] Autologous Fat Graft for Soft Tissue Camouflage in Craniofacial ... <https://pmc.ncbi.nlm.nih.gov/articles/PMC6967170/>
- [9] Multidisciplinary Treatment of Hemifacial Microsoma <https://pmc.ncbi.nlm.nih.gov/articles/PMC11587098/>
- [10] Understanding the Educational and Social Difficulties in Children with Hemifacial Microsoma – A Literature Review <https://apcz.umk.pl/QS/article/view/56644>
- [11] Craniofacial anatomical determinants of pediatric sleep-disordered breathing: A comprehensive review <https://onlinelibrary.wiley.com/doi/10.1111/jopr.13984>
- [12] The Pattern and Profile of Orofacial Clefts in Somaliland: A Review of 40 Consecutive

- Cleft Lip and Palate Surgical Camps <https://journals.lww.com/10.1097/SCS.00000000000010340>
- [13] Postural balance in the comprehensive rehabilitation of adolescents with cleft lip and palate and maxillofacial anomalies: A literature review <https://journals.eco-vector.com/turner/article/view/567935>
- [14] [Expert consensus on core data elements and definitions for adult invasive mechanical ventilation (2024)]. <https://www.semanticscholar.org/paper/f0e4dec8af7467f52c7fca57c24ffe096d7296c3>
- [15] Efficacy and safety of sagittal synostosis surgery in older (> 12 months) patients: a systematic review and meta-analysis. <https://link.springer.com/10.1007/s00381-024-06472-y>
- [16] The Survival Rate of the Retention System for Extraoral Maxillofacial Prosthetic Implant: A Systematic Review <https://www.cureus.com/articles/299117-the-survival-rate-of-the-retention-system-for-extraoral-maxillofacial-prosthetic-implant-a-systematic-review>
- [17] New Frontiers in Craniofacial Surgery - Harnessing Nature's Healing Power <https://pmc.ncbi.nlm.nih.gov/articles/PMC11828052/>
- [18] Evaluating International Diagnostic, Screening, and Monitoring Practices for Craniofacial Microsoma and Microtia: A Survey Study <https://journals.sagepub.com/doi/pdf/10.1177/10556656221093912>
- [19] Damaging variants in FOXI3 cause microtia and craniofacial microsoma <https://pmc.ncbi.nlm.nih.gov/articles/PMC9885525/>
- [20] A New Classification Based on the Kaban's Modification for Surgical Management of Craniofacial Microsoma <https://pmc.ncbi.nlm.nih.gov/articles/PMC3052660/>
- [21] 1. Mutations in FOXI3 Cause Microtia and Craniofacial Microsoma <https://pmc.ncbi.nlm.nih.gov/articles/PMC10194625/>
- [22] Evaluating International Diagnostic, Screening, and Monitoring Practices for Craniofacial Microsoma and Microtia: A Survey Study <https://pmc.ncbi.nlm.nih.gov/articles/PMC10466995/>
- [23] Growth characteristics and classification systems of hemifacial microsoma: a literature review <https://pmc.ncbi.nlm.nih.gov/articles/PMC11088588/>
- [24] Orthognathic Surgery in Craniofacial Microsoma: Treatment Algorithm <https://pmc.ncbi.nlm.nih.gov/articles/PMC4323398/>
- [25] Characterising the speech phenotype in individuals with craniofacial microsoma: a scoping review protocol <https://pmc.ncbi.nlm.nih.gov/articles/PMC9980328/>
- [26] Early Experiences of Parents of Children With Craniofacial Microsoma. <https://pmc.ncbi.nlm.nih.gov/articles/PMC11081840/>
- [27] Management of unilateral craniofacial microsoma with ... <https://pubmed.ncbi.nlm.nih.gov/37987216/>
- [28] Hemifacial microsoma – a review of the literature of current ... <https://otorhinolaryngologypl.com/article/01.3001.0054.7072/en>
- [29] Outcomes in Hybrid Breast Reconstruction: A Systematic Review <https://pmc.ncbi.nlm.nih.gov/articles/PMC9503593/>
- [30] Clinical and radiological profile of a neonate with ... <https://wjwch.com/clinical-and-radiological-profile-of-a-neonate-with-craniofacial-microsoma-a-case-snippet/>
- [31] CLASSIFICATION AND MANAGEMENT OF HEMIFACIAL ... <https://pmc.ncbi.nlm.nih.gov/articles/PMC7513375/>
- [32] Outcomes following Autologous Fat Grafting for Oncologic Head and ... <https://pubmed.ncbi.nlm.nih.gov/30148782/>