



ORIGINAL RESEARCH PAPER

Orthodontics

HEMIFACIAL MICROSOMIA: DENTAL ANOMALIES AND THEIR INTERCEPTIVE ORTHODONTIC MANAGEMENT – A LITERATURE REVIEW

KEY WORDS: “hemifacial microsomia”, “dental anomalies”, “craniofacial malformations”, “orthodontic management”.

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ABSTRACT

Introduction: Hemifacial microsomia (HFM) is the second most common congenital craniofacial malformation, characterized by significant dental anomalies (DA) that affect both functionality and aesthetics. This study aims to analyze the DA associated with HFM and evaluate the effectiveness of interceptive orthodontic treatment in its management. **Methods:** A systematic literature review was conducted using scientific databases such as PubMed. Studies published in English and Spanish from 2014 onwards that evaluated DA in HFM patients and orthodontic management strategies were included. Exclusion criteria involved animal studies, purely surgical investigations, and publications without full-text access. **Results:** A total of 11 studies were selected for analysis. The most prevalent DA included dental agenesis (33%), delayed eruption, microdontia, and dental malpositions. Interceptive orthodontic treatment with functional appliances proved effective in correcting mandibular asymmetry and leveling the occlusal plane, particularly in mild to moderate cases. Severe cases required a combination of surgical and orthopedic approaches. The heterogeneity of protocols and lack of long-term follow-up studies limit the generalizability of the findings. **Conclusion:** DA are highly prevalent in HFM patients, and early management through interceptive orthodontics can significantly enhance functionality and aesthetics. However, implementing standardized protocols and conducting robust prospective studies is essential to optimize outcomes and personalize treatments based on the severity of each case.

INTRODUCTION

Hemifacial Microsomia (HFM) is a congenital malformation that predominantly affects tissues derived from the first and second branchial arches. This condition is characterized by asymmetry in the formation of the craniofacial skeleton and soft tissues, which can lead to a variety of anomalies. These include microphthalmia (small eyes), ocular asymmetry, preauricular fistulas, microtia or anotia (small or malformed ears), ear dysplasia with or without hearing loss, dental malocclusion, and macrostomia (abnormally large mouth) (Luo et al., 2023). The first signs of skeletal problems manifest in the mandible, and facial asymmetry worsens as the child grows, with the affected side failing to compensate for growth (Ranjitkar et al. 2023).

The etiology of HFM is not yet fully understood, but it is believed to be linked to a combination of genetic and environmental factors. Some studies suggest that abnormalities in cranial neural crest cells (CNCCs), Meckel's cartilage, and vascular malformations may contribute to the development of this condition (Luo et al., 2023). The incidence of HFM is estimated to be between 1:3,500 and 1:5,600 live births (Véliz-M et al., 2016), making it the second most common craniofacial malformation after cleft lip and palate (Camacho et al., 2014). This malformation has a significant impact both aesthetically and functionally, making it a relevant clinical challenge for multiple health disciplines.

Hemifacial microsomia can be classified using the Pruzansky-Kaban system, which categorizes mandibular abnormalities into three main grades based on the development of the ramus and mandibular condyle. Grade I is characterized by a smaller but functional mandible; Grade II is subdivided into IIa and IIb, depending on whether the temporomandibular joint is functional or not, while Grade III represents a complete absence of joint structures and severely compromised mandibular development (Luo et al., 2023; Camacho et al., 2014). This classification is fundamental for planning therapeutic interventions, as it allows surgical and orthodontic approaches to be tailored to the severity of the condition.

In the dental field, patients with HFM present a wide range of dental anomalies, such as agenesis, hypodontia, supernumerary teeth, delayed dental eruption,

malpositioned teeth, and structural abnormalities (Camacho et al., 2014). These alterations not only complicate the development of dental occlusion but also affect patients' quality of life, causing both functional and aesthetic problems. Due to the diversity and complexity of these anomalies, early diagnosis and interdisciplinary management are crucial for achieving effective treatment.

Orthodontic treatment in HFM patients presents considerable challenges, as the associated dental alterations not only complicate occlusal development but also affect masticatory function, speech, and facial aesthetics. These difficulties can profoundly impact patients' self-esteem and well-being. In this context, interceptive orthodontics and functional orthopedics emerge as key approaches to addressing these alterations from early stages, aiming to prevent major complications and improve both functionality and facial aesthetics.

Interceptive orthodontics focuses on the early correction of dental anomalies, helping to prevent the need for more invasive treatments at later stages. Functional orthopedics can be used to modify the growth and development of the jaws, enhancing facial harmony and dental occlusion in HFM patients. Since the dental anomalies associated with this condition vary in type and severity, it is essential to personalize orthodontic treatment to address each patient's specific needs.

The objective of this review is to examine the main dental anomalies observed in patients with hemifacial microsomia and explore how interceptive orthodontic treatment and functional orthopedics can contribute to the appropriate management of these alterations. This review aims to provide a comprehensive overview of dental anomalies in hemifacial microsomia and the relevance of interceptive orthodontic treatment, informing clinicians and researchers about the importance of early intervention in these patients.

METHODS

A literature review was conducted to analyze dental anomalies in patients with hemifacial microsomia (HFM). The information search was carried out in the Medline database (via PubMed) using various combinations of keywords. Additionally, a manual search was conducted in secondary

sources, including references from previously selected studies.

The study selection process was conducted in two stages: first, based on title and abstract to determine initial relevance, and subsequently, through full-text review to evaluate definitive inclusion in the analysis.

Inclusion Criteria: The review included Primary studies, case reports, prospective and retrospective studies, or systematic reviews published in Spanish or English from 2014 onwards.

Studies that directly addressed hemifacial microsomia and associated dental anomalies.

Exclusion Criteria: The review excluded Animal studies, Publications in languages other than Spanish or English.

Studies published before 2014, Research that did not specifically address dental anomalies in the context of HFM, Studies exclusively focused on surgical aspects or unrelated to dentistry or orthodontics, Opinion articles, editorials, and conference abstracts without full accessible content.

Search Strategy

The search strategy included the following keywords, combined using Boolean operators as follows:

- "Hemifacial microsomia" AND "Dental Anomalies"
- "Craniofacial malformations" AND "Dental Anomalies" AND "Hemifacial microsomia"
- "Hemifacial microsomia" AND "Dental Anomalies" AND "Orthodontic management"
- "Hemifacial microsomia" AND "Orthodontic management"
- "Hemifacial microsomia" AND "Interceptive orthodontics" OR "Orthopedic"

A total of 126 articles were found, and 22 were selected for full reading. The selected articles were critically evaluated in terms of relevance, methodological quality, and scientific rigor. The final sample consisted of 11 studies that met the defined criteria and provided information on the most common dental anomalies in patients with hemifacial microsomia, as well as on interceptive orthodontic treatment to address these alterations.

- **Among the evaluated dental anomalies, the review considered:**
- Dental agenesis
- Delayed dental development
- Size and morphological anomalies
- Other alterations, such as impacted teeth, interdental spaces, neonatal teeth, and supernumerary teeth.

RESULTS

In this literature review, 11 primary studies documenting dental anomalies in patients with hemifacial microsomia (HFM) and the interceptive orthodontic treatment strategies used for their management were analyzed. The results obtained are synthesized into the following key categories:

1. Prevalence And Types Of Dental Anomalies

It was identified that dental anomalies are significantly more common in patients with HFM compared to the general population. The identified alterations include:

Dental Agenesis: Up to 33% of patients diagnosed with HFM present tooth absence, with mandibular lateral incisors and maxillary second premolars being the most frequently affected (Ranjitkar et al., 2023; Elsten et al., 2020; Ahiko et al., 2020).

Delayed Dental Eruption: Studies such as that by Ahiko et al.

(2020) report a significant delay in the eruption of mandibular molars on the affected side.

Microdontia And Alterations In Tooth Size: Smaller teeth are observed on the affected side, contributing to occlusal and facial asymmetry (Ranjitkar et al., 2023; Elsten et al., 2020).

Morphological Alterations: These include supernumerary teeth, enamel hypoplasia, and dental malpositions (Luo et al., 2023; Elsten et al., 2020). Additionally, cases of amelogenesis imperfecta related to enamel hypoplasia have been documented (Camacho et al., 2014).

The study by Salem et al. (2021) highlights that dental anomalies in patients with HFM are highly prevalent and vary in severity depending on the degree of mandibular involvement. Among the most common alterations are tooth impaction, ectopia, and delayed eruption, which significantly impact occlusion and oral functionality (Salem et al., 2021).

2. Impact Of Interceptive Orthodontic Treatment

Early management of these anomalies through interceptive orthodontics and functional orthopedics has shown significant benefits:

Mandibular Growth Modifications: The use of asymmetrical functional appliances, such as the modified functional activator, improves the growth of the affected mandibular ramus, contributing to greater facial symmetry (Aiyar et al., 2024; Nouri & Farzan, 2015). This approach has also shown to reduce chin deviation toward the affected side (Nouri & Farzan, 2015).

Correction Of Occlusal Canting: Appliances like the Bionator have proven effective in leveling the occlusal plane in patients with mandibular vertical deficiencies (Aiyar et al., 2024).

Reduction In The Need For Surgery: In mild to moderate cases, interceptive treatment has prevented the need for more invasive surgical procedures, such as distraction osteogenesis (Nouri & Farzan, 2015).

3. Factors Influencing Treatment Success

Several critical factors influencing orthodontic management success in HFM were identified:

Severity Degree: Patients classified as Pruzansky I and IIa respond better to functional orthopedics, while more severe cases (IIb and III) often require complementary surgical interventions (Aiyar et al., 2024).

Treatment Adherence: Compliance with the use of functional appliances is essential to achieving optimal results, especially in long-term treatments (Nouri & Farzan, 2015).

Accurate Diagnosis: The use of computed tomography (CT) allows for a three-dimensional assessment of mandibular asymmetries, enabling more precise treatment planning (Camacho et al., 2014; Ahiko et al., 2020).

Early diagnosis of dental anomalies and craniofacial malformations is key to establishing an appropriate treatment plan. According to Akram et al. (2020), the role of the orthodontist is crucial in the initial evaluation of mandibular malformations and their impact on functionality and aesthetics. The study highlights that advanced imaging technologies, such as CT scans and 3D imaging techniques, allow for more precise evaluations of structural and dental alterations, facilitating the planning of interceptive and orthopedic treatments from early ages (Akram et al., 2020).

Age of treatment initiation: Early intervention, ideally during the mixed dentition stage, optimizes results by taking advantage of maximum growth periods (Aiyar et al., 2024;

López & Gutiérrez, 2022).

DISCUSION

Comparison With Previous Studies

The findings of this review align with previous research emphasizing the importance of an early and multidisciplinary approach in the management of HFM. Studies such as those by Camacho et al. (2014) and Luo et al. (2023) highlight the relevance of interceptive techniques in reducing future complications. However, this review also underscores the need for more standardized protocols, in contrast to the methodological heterogeneity observed in the literature.

Strengths And Weaknesses Of Interceptive Treatment

Interceptive treatment offers significant advantages in mild to moderate cases, such as reducing the need for invasive surgeries (Nouri & Farzan, 2015). However, its effectiveness is limited in patients with severe HFM, where surgical interventions remain essential. Additionally, as noted by Aiyar et al. (2024), treatment success largely depends on patient adherence and accurate diagnosis.

Clinical Implications

The results highlight the importance of personalizing treatment based on factors such as severity degree and patient age. Moreover, the application of advanced three-dimensional imaging techniques could improve diagnostic accuracy and therapeutic success (Ahiko et al., 2020).

Interdisciplinary Management

The treatment of HFM requires collaboration among physicians, dentists, maxillofacial surgeons, orthodontists, and psychologists. This comprehensive approach, as highlighted by Camacho et al. (2014), addresses both the physical and emotional needs of patients.

New Technologies

The use of tools such as 3D printing and artificial intelligence could revolutionize treatment planning. These technologies enable the creation of personalized models and precise simulations of expected outcomes (Luo et al., 2023).

Limitations Of Available Studies

Most of the reviewed studies present observational designs and small sample sizes, leading to a high risk of bias (Aiyar et al., 2024). Additionally, significant heterogeneity exists in the protocols used, making direct comparisons between treatments difficult (Ahiko et al., 2020). A lack of long-term follow-up studies on distraction osteogenesis was also noted (Luo et al., 2023).

Future Perspectives

There is a need for controlled prospective studies with larger samples to evaluate treatment efficacy and develop standardized protocols. Moreover, incorporating patient-reported outcome measures (PROMs) could enhance the evaluation of the functional and aesthetic impact of treatment (Nouri & Farzan, 2015). The combination of orthopedic and surgical techniques shows promise in moderate to severe cases, but further research is required to establish concrete benefits (Camacho et al., 2014).

CONCLUSIONS

Hemifacial Microsomia (HFM) represents a significant clinical challenge due to the complexity of associated dentofacial anomalies and their functional and aesthetic impact. This analysis highlights that early intervention through interceptive orthodontic treatments can mitigate many of the associated complications, especially in mild to moderate cases. The results suggest that accurate diagnosis, the use of advanced technologies such as three-dimensional tomography, and personalized treatment are essential to optimizing outcomes.

However, more severe cases still require a combined approach integrating surgical and orthopedic interventions, emphasizing the importance of interdisciplinary management. Despite advancements, the lack of standardized protocols and studies with robust methodological designs limits the ability to generalize current findings.

Future research should focus on developing evidence-based clinical guidelines, integrating emerging technologies, and assessing the impact of treatment on patients' quality of life through patient-reported outcome measures (PROMs). Ultimately, this comprehensive approach could not only enhance clinical outcomes but also improve the patient experience, promoting a more effective and patient-centered rehabilitation.

REFERENCES

- Luo, S., Sun, H., Bian, Q., Liu, Z., & Wang, X. (2023). The etiology, clinical features, and treatment options of hemifacial microsomia. *Oral Diseases*, 29(6), 2449-2462. <https://doi.org/10.1111/odi.14508>
- Ranjitkar, S., Wong, C., Edwards, S., & Anderson, P. J. (2023). Computed tomography assessment of hypodontia and crown size in hemifacial microsomia. *Archives of Oral Biology*, 147, 105633. <https://doi.org/10.1016/j.archoralbio.2023.105633>
- Véliz-M, S., Agurto-V, P., & Leiva-V, N. (2016). Microsomia hemifacial. Revisión de la literatura. *Revista Facultad de Odontología Universidad de Antioquia*, 27(2), 404-424. <https://doi.org/10.17533/udea.rfo.v27n2a9>
- Camacho, S. M., Pabón, A. M., & Hernández, J. A. (2014). Características dentofaciales en los pacientes con microsomia hemifacial. *Revista Estomatología*, 27(2), 45-58.
- Elsten, E., Caron, C., Dunaway, D. J., Padwa, B. L., & Forrest, C. (2020). Dental anomalies in craniofacial microsomia: A systematic review. *Orthodontics & Craniofacial Research*, 23(1), 16-26. <https://doi.org/10.1111/ocr.12351>
- Ahiko, N., Baba, Y., Tsuji, M., Suzuki, S., Kaneko, T., Kindaichi, J., et al. (2020). Investigation of maxillofacial morphology and dental development in hemifacial microsomia. *Journal of Cranio-Maxillofacial Surgery*, 48(4), 223-230.
- Salem, M. B., Perrin, J. P., Corre, P., & Boeffard, C. (2021). Dental anomalies in craniofacial microsomia and condylo-mandibular dysplasia: A retrospective study of 103 patients. *Orthodontics & Maxillofacial Surgery Research*, 45(1), 10-22.
- Aiyar, A., Pedersen, T. K., Resnick, C. M., Nørholt, S. E., Verna, C., & Stoustrup, P. B. (2024). Management of unilateral craniofacial microsomia with orthopaedic functional appliances: A systematic literature review. *Orthodontics & Craniofacial Research*, 27(Suppl. 1), 131-140. <https://doi.org/10.1111/ocr.12729>
- Nouri, M., & Farzan, A. (2015). Nonsurgical treatment of hemifacial microsomia: A case report. *Iranian Red Crescent Medical Journal*, 17(11), e19920. <https://doi.org/10.5812/ircmj.19920>
- Akram, A., McKnight, M. M., Bellardie, H., Beale, V., & Evans, R. D. (2020). Craniofacial malformations and the orthodontist. *Journal of Orthodontic & Maxillofacial Surgery*, 23(3), 334-340.
- López, D. F., & Gutiérrez, M. (2022). Microsomia hemifacial: Alternativas de tratamiento – una revisión sistemática. *Journal of Clinical Pediatric Dentistry*, 46(2), 112-121.