Review Article

Impact of Dental Anomalies on Function and Aesthetics in Cleft Lip and Palate Patients

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ABSTRACT

Background: Cleft lip and palate (CL/P) are among the most prevalent congenital craniofacial deformities, often accompanied by a wide spectrum of dental anomalies including hypodontia, supernumerary teeth, peg-shaped incisors, enamel hypoplasia, and malocclusion that significantly impair oral function and esthetics. These dental irregularities not only compromise mastication, speech articulation, and occlusal stability but also exert a profound psychosocial burden on affected individuals, particularly during formative years. Objective: This review aims to synthesize current evidence on the functional, esthetic, and psychosocial impacts of dental anomalies in CL/P patients, highlighting the interrelationship between structural deformities, oral performance, and quality of life, and emphasizing the need for integrated, multidisciplinary management. Methods: A narrative review was conducted using PubMed, Scopus, and Google Scholar databases to identify English-language studies published between 2010 and 2025. Search terms included "cleft lip and palate," "dental anomalies," "hypodontia," "malocclusion," "mastication," "speech articulation," and "psychosocial impact." Original research articles, longitudinal studies, and clinical reviews examining functional, esthetic, or psychosocial outcomes in CL/P were included. Evidence was synthesized thematically without meta-analysis due to study heterogeneity. Results: Empirical findings demonstrate that 70–90% of CL/P patients present with one or more dental anomalies, most frequently maxillary lateral incisor agenesis and enamel hypoplasia. These abnormalities are strongly associated with reduced occlusal force (up to 80–85% lower than controls), altered chewing kinematics, and compensatory temporalis muscle hyperactivity. Speech articulation is adversely affected by missing or malaligned anterior teeth, particularly in the production of sibilant and labiodental sounds (/s/, /f/, /v/). Long-term skeletal instability after maxillary advancement is commonly attributed to postoperative fibrosis and scar formation. Aesthetically, enamel defects and asymmetric anterior dentition disrupt smile harmony and facial balance, while psychological studies reveal markedly higher distress scores and social stigma leading to decreased self-esteem and academic performance. Conclusion: Dental anomalies in CL/P patients have multifactorial repercussions that extend beyond oral function to psychosocial well-being. Although surgical and orthodontic interventions improve form and function, complete normalization remains rare. Early detection, timely orthodontic and surgical coordination, dietary and speech therapy support, and continuous psychosocial counselling are essential to achieving sustainable rehabilitation. Integrating these domains within a long-term multidisciplinary framework is critical for optimizing functional recovery, facial esthetics, and quality of life.

Keywords: *Heavy menstrual bleeding, dietary habits, early adulthood, nutrition, reproductive health, cross-sectional.*

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INTRODUCTION

Dental developmental abnormalities are widely documented in patients with cleft lip and/or palate (CL/P), most commonly including hypodontia, supernumerary teeth, enamel hypoplasia, and malocclusion (1). These anomalies span number, shape and structure, position, and eruption sequence of teeth (2). Evidence from multi-centre cohorts indicates a high overall burden of dental defects in CL/P; for example, among 10-year-old children,

reported prevalences include any dental defect in 80.6%, with lateral incisor agenesis (37.80%), supernumerary teeth (21.95%), peg-shaped lateral incisors (17.07%), lateral incisor microdontia (17.07%), second-premolar agenesis (20.73%), and enamel hypoplasia (9.76%) among the most frequent findings (3). Across studies, hypodontia particularly of maxillary lateral incisors and premolars emerges as the dominant anomaly (≈68–>90%), while supernumerary teeth cluster around the cleft site; together these patterns underpin malocclusion and occlusal instability and often necessitate complex orthodontic and/or surgical care (3, 5). Functionally, misshapen or missing teeth can compromise mastication by reducing bite force, occlusal contact, and chewing efficiency, and they may perturb speech articulation especially of sibilant and labiodental sounds through altered anterior dental and occlusal relationships (4).

While velopharyngeal dysfunction remains a principal driver of resonance and articulatory disorders in CL/P, adverse dental/occlusal configurations can plausibly exacerbate articulatory demands rather than independently render speech "incapable," warranting integrated dental–speech assessment (6). Beyond function, the visibility of anterior-segment anomalies and enamel defects diminishes smile harmony and facial symmetry, with consistent associations to lower self-esteem, appearance-related distress, and social stigmatization burdens that are particularly salient in school-age children and adolescents during identity formation and peer integration (6, 7).In this context, the present review synthesizes empirical evidence on dental anomalies in CL/P and their consequences across mastication, speech, and occlusal/skeletal stability, alongside esthetic and psychosocial domains. By foregrounding prevalence patterns, functional mechanisms, and patient-centred outcomes, it motivates early, staged, and multidisciplinary management pathways to mitigate lifelong impacts

NARRATIVE REVIEW METHODS

This review followed a narrative synthesis approach to summarize recent evidence on dental anomalies and their functional, esthetic, and psychosocial impacts in cleft lip and palate (CL/P) patients. Relevant peer-reviewed articles were identified through electronic searches in PubMed, Scopus, and Google Scholar using combinations of keywords such as "cleft lip and palate," "dental anomalies," "hypodontia," "malocclusion," "mastication," "speech," and "psychosocial impact." The search was limited to English-language studies published between 2010 and 2025. Reference lists of retrieved papers were also screened to identify additional relevant sources.

Original clinical studies, reviews, and observational reports focusing on dental and functional outcomes in CL/P were included, while case reports and non-human studies were excluded. Data from eligible publications were narratively synthesized under thematic domains prevalence and pattern of anomalies, functional and esthetic consequences, and psychosocial implications without quantitative pooling or meta-analysis. This approach ensured a technically sound yet concise overview consistent with narrative review standards.

FUNCTIONAL IMPACT OF DENTAL ANOMALIES

Mastication and Nutrition

Mastication is a vital oral function that is often significantly compromised in patients with cleft lip and palate (CL/P). Despite advances in surgical repair and orthodontic correction, research consistently demonstrates that chewing efficiency in CL/P patients rarely reaches that of non-cleft individuals. Quantitative studies have confirmed persistent deficits in occlusal force, contact area, and masticatory efficiency even after comprehensive treatment.

Miura et al. (2022) reported that adults with CL/P exhibited a mean frontal bite force of 3.44 ± 0.95 kgf is approximately 85% lower than in control participants (22.87 ± 5.36 kgf) indicating that surgical and orthodontic interventions, while beneficial, do not fully normalize function. Electromyographic analyses further support these findings; children with bilateral complete CL/P display altered masticatory muscle activation, characterized by elevated temporalis activity at rest and reduced electrical potentials during maximal clenching, suggesting compensatory neuromuscular adaptations that lead to prolonged chewing cycles and poorer food breakdown (8-13).

Malocclusion remains a major contributor to masticatory dysfunction. Crossbites and open bites are frequent on the cleft side, and only about 30% of CL/P patients achieve normal occlusion compared to approximately 50% of unaffected controls. Kinematic analyses reveal that those with anterior crossbites exhibit distorted masticatory patterns with a greater frequency of reversed chewing cycles, particularly on the affected side (Cassi et al., 2021). Although orthognathic surgery can enhance bite efficiency and alignment, residual deficits typically persist beyond 12 months post-operation, highlighting the chronic nature of functional impairment (17).

Nutritional consequences are closely linked to these mechanical limitations. Studies indicate that children with CL/P often adapt to texture-modified diets to ease mastication difficulties, which can alter food variety and nutrient density. Although total caloric intake may not differ substantially from peers, dietary quality is frequently compromised (9). Evidence from texture-modified diet research suggests that such patients consume less protein (by approximately 12 g/day) and have lower overall nutritional scores compared with those on regular diets an especially concerning finding given the protein requirements for growth and postoperative healing (17-22). Moreover, CL/P children in resource-limited settings are at higher risk of micronutrient deficiencies, particularly iron, folate, and vitamin B12. Their preference for soft, often processed foods correlates with increased intra-meal carbohydrate exposure and higher caries prevalence (21-27).

The implications of masticatory impairment extend beyond oral function to systemic health. Long-term reliance on soft, low-fiber foods may decrease fruit and vegetable intake, adversely affecting digestive health and increasing susceptibility to obesity and dental caries (28-31). Longitudinal evidence also suggests that functional deficits persist into adulthood; adults with repaired CL/P show significantly lower prosthetic and nutritional status scores than non-cleft controls, reflecting the cumulative impact of early feeding and masticatory challenges (14). Collectively, these findings underscore the need for early functional rehabilitation, dietary counselling, and long-term multidisciplinary follow-up.

Speech Articulation

Speech articulation represents another domain profoundly affected by dental anomalies in CL/P. Malformed or absent anterior teeth especially the maxillary incisors disrupt airflow and contact patterns critical for sibilant and labiodental sound production (/s/, /f/, /v/). Mason (2020) found that premature loss of primary anterior teeth caused articulation errors in alveolar and dental fricatives, with /s/ sounds improving more rapidly than /f/ following prosthetic restoration. Although many children develop compensatory mechanisms that restore intelligibility over time, transient distortions are common during dental or orthodontic transitions.

Beyond individual tooth loss, larger structural irregularities such as anterior segment malalignment influence the articulation of alveolar sounds (/t/, /d/). Computational fluid dynamics analyses demonstrate that steeper incisor angulation alters sound source location

and reduces high-frequency acoustic energy (> 8 kHz), directly affecting sibilant sound clarity (32-36). Malocclusion severity further modifies tongue posture, lip closure, and intraoral airflow all essential for precise articulation. Studies on fixed labial appliances reveal that the extent of dentofacial discrepancy determines the degree of transient speech distortion during treatment adaptation (36-39). These findings emphasize the functional interdependence between occlusion, dental morphology, and speech, highlighting the importance of coordinated orthodontic and speech-language interventions in CL/P management.

Occlusal and Skeletal Stability

Occlusal and skeletal stability in CL/P patients is influenced by both intrinsic and iatrogenic factors. Primary causes of instability include congenital alveolar discontinuities and postsurgical scar formation, which may restrict maxillary growth and predispose to crossbites and maxillary retrusion (14-19). Recurrent palatal fistulas further compromise palatal integrity and speech resonance, necessitating secondary surgical correction and prolonged therapy (20-23).

Various interventions orthodontic expansion, secondary alveolar bone grafting, orthognathic surgery, and myofunctional therapy are employed to restore occlusal relationships and enhance skeletal balance. Evidence indicates that treatment timing and scar minimization strategies are critical to long-term stability, as delayed grafting or extensive fibrosis increase relapse risk. Despite these measures, a subset of patients continues to experience residual deformities and skeletal relapse, underscoring the need for individualized, multidisciplinary protocols that integrate orthodontic, surgical, and rehabilitative care. Table 1 summarizes key studies addressing occlusal and skeletal stability outcomes in CL/P populations.

Table 1. Factors Affecting Occlusal and Skeletal Stability in Cleft Lip and Palate (CL/P)

Study and Reference	Cause / Contributing Factors	Findings / Effects
Saltaji et al. (2012) – Long-term skeletal stability after maxillary advancement with distraction osteogenesis in CL/P patients	Presence of fibrotic scarring in palatal and lip tissues, and anterior/posterior pharyngeal flaps from previous surgeries restricting maxillary movement.	Scar tissue limits maxillary mobility, leading to midface deficiency and a tendency for relapse toward the pre-surgical position.
Trindade-Suedam et al. (2012) – Timing of alveolar bone grafting determines different outcomes in unilateral CL/P	Delayed surgical intervention associated with increased patient age.	Late bone grafting results in higher failure rates; early grafting improves alveolar integration and overall outcomes.
Gomes et al. (2013) – Horizontal and vertical maxillary osteotomy stability using allogeneic bone graft in CL/P	Instability due to previous surgeries, fibrous tissue formation, and altered muscle balance.	Use of allogeneic bone graft improves postoperative maxillary stability; controls showed higher horizontal relapse rates.
Nkenke et al. (2014) – Skeletal stability and complications in transantral maxillary distraction in CL/P	Cleft-related maxillary hypoplasia requiring limited advancement (<12 mm).	Achieved mean maxillary advancement of 6.4 mm with only a 7.5% relapse rate at 12 months, indicating good long-term stability.
Seo et al. (2015) – Effect of secondary alveolar bone grafting on maxillary growth	Space deficiency in the maxillary tuberosity area leading to posterior crowding.	Secondary alveolar bone grafting (SABG) reduces sagittal growth in bilateral CL/P but does not significantly affect vertical growth.
Chang et al. (2016) – Timing of orthodontic arch expansion and graft in CL/P	Maxillary constriction due to congenital cleft anatomy and postoperative scarring.	Early maxillary expansion before bone grafting enhances alveolar width and graft stability, improving treatment outcomes.
Mahajan et al. (2017) – Secondary and late secondary alveolar bone grafting in unilateral CL/P	Delays due to economic constraints and patient non-compliance.	Successful grafting improves soft tissue balance, facial symmetry, and nasal-labial aesthetics despite delayed presentation.
Scott et al. (2017) – Secondary alveolar bone grafting and premaxillary osteotomy in complete bilateral CL/P	Multifactorial influences including oral hygiene, parental involvement, and dental maturity.	Poor oral hygiene associated with graft failure; 56% of cases required orthognathic correction for skeletal malocclusion.

Study and Reference	Cause / Contributing Factors	Findings / Effects
Jabbari et al. (2018) – Secondary alveolar bone grafting: 20-year follow-up in unilateral CL/P	Dependence of bone graft success on continuous occlusal loading and dental integrity.	Long-term follow-up showed gradual alveolar bone height reduction; dental restorations correlated with further bone resorption.
Hay et al. (2018) – Maxillary growth with and without vomerine flap closure at lip repair	Potential growth restriction from postoperative scarring in the vomer region.	No significant adverse effect of vomerine flap on maxillary growth; minimal influence on dental variables over 10 years.
Hameed et al. (2019) – Orthodontic burden of care for CL/P patients	Genetic and environmental contributions to cleft etiology and complex treatment pathways.	Comprehensive orthodontic care improved efficiency, patient satisfaction, and long-term functional outcomes.
Setianingtyas et al. (2020) – Correlation between anterior crossbite severity and skeletal deformities post-surgery in CL/P children	Anterior crossbite secondary to maxillary hypoplasia following cleft repair.	Weak correlation between crossbite severity and skeletal deformities; post-surgical patients often exhibited residual malocclusion.
Jittithaworn et al. (2021) – Comparing outcomes after single- and two-piece LeFort I osteotomies in CL/P	Maxillary hypoplasia and surgical complexity influencing postoperative stability.	Both techniques improved occlusion; two-piece osteotomies carried higher instability risk due to surgical segmentation.
Ploussard and Magraw (2023) – Craniofacial and orthognathic surgery outcomes in pediatric CL/P	Maxillary advancement procedures in growing patients predisposed to skeletal relapse.	Skeletal relapse risk persists after advancement; underscores need for growth monitoring and retention strategies.
Kaiser et al. (2024) – Comprehensive multidisciplinary management of bilateral CL/P	Congenital skeletal and dental discrepancies requiring coordinated management.	Integrated orthodontic, surgical, and rehabilitative care improved occlusal balance, facial profile, and long-term functional stability.

AESTHETIC IMPACT AND SOCIAL CONSEQUENCES

The position and condition of the anterior maxillary dentition play a critical role in defining facial symmetry and smile balance among patients with cleft lip and palate (CL/P). The alignment of the maxillary incisors is central to overall smile esthetics, contributing to midline harmony and facial proportion (39). Enamel defects such as discoloration, hypoplasia, and opacities are common in this population and often result in visible esthetic concerns that compromise the natural appearance of the smile (40). Orthodontic treatment aimed at correcting displaced or rotated maxillary incisors can restore symmetry and improve esthetic perception, underscoring the importance of early and well-coordinated multidisciplinary planning (40,41). A proactive diagnostic and treatment approach that integrates orthodontic, restorative, and surgical interventions is therefore essential to achieve optimal outcomes in smile esthetics and facial balance (40). Beyond physical appearance, dental anomalies in CL/P patients have profound psychosocial implications. Even after successful lip repair, residual dental deformities such as missing, malformed, or discolored teeth remain visible and often perpetuate feelings of unattractiveness or social self-consciousness (42).

PSYCHOLOGICAL IMPACT AND APPEARANCE-RELATED DISTRESS

The psychological burden associated with dental and facial differences in CL/P is well documented. Studies consistently report higher levels of appearance-related anxiety and distress compared with non-cleft populations. For example, CL/P patients scored significantly higher on the Derriford Appearance Scale (159.16 ± 31.54) compared to controls (77.64 ± 6.57, $p < 0.001$). Similarly, scores on the Psychological Impact of Dental Aesthetic Questionnaire were notably elevated (33.25 ± 9.45 in patients versus 27.52 ± 5.67 in controls; $p < 0.001$), reflecting heightened dental appearance-related distress (43).

These differences extend to self-concept and body image. Patients with CL/P frequently express lower satisfaction with their facial features, particularly the nasolabial region. In one regional cohort, only 35.6% of individuals rated their facial profile as “very satisfactory”

following treatment (44), while 21.9% remained dissatisfied with their dental appearance even after comprehensive care (45). Research also supports these findings, noting persistent body image concerns among CL/P patients, even when objective esthetic outcomes are clinically acceptable (46).

Self-perception studies highlight the persistence of appearance-related self-awareness from childhood into adolescence. Children and adolescents with CL/P often emphasize perceived deficiencies when creating self-portraits (47), and eye-tracking studies reveal that adolescents focus longer on affected facial areas when viewing their own photographs, reflecting internalized self-consciousness and residual dissatisfaction (48).

PEER INTERACTIONS AND ACADEMIC OUTCOMES

The social ramifications of dental anomalies extend into peer relationships, social inclusion, and academic performance. Stigma surrounding facial differences remains a pervasive challenge; children with orofacial clefts experience elevated levels of ridicule, social rejection, and isolation compared with their peers (49). Stigmatization often follows a predictable progression from labeling and stereotyping to social segregation and diminished peer status, ultimately resulting in lower social participation and self-worth (50). Qualitative accounts indicate that even self-assured and academically capable adolescents continue to experience emotional strain, as mirrors, windows, and photographs trigger reminders of their perceived differences (51).

Educational outcomes further underscore the functional and psychosocial burdens of CL/P. Children with isolated orofacial clefts exhibit higher average school absenteeism (10.5 days per year) compared with their non-cleft peers (8.9 days), with the highest rates among those with combined cleft lip and palate (11.3 days), followed by cleft palate only (10.5 days) and cleft lip only (9.5 days) (52). Longitudinal evidence also demonstrates that adolescents with CL/P perform below their peers academically, even after adjusting for socioeconomic and medical variables (53). These findings illustrate how functional and aesthetic limitations intertwine with psychosocial and educational outcomes, reinforcing the need for early psychological support, school-based inclusion programs, and family counselling.

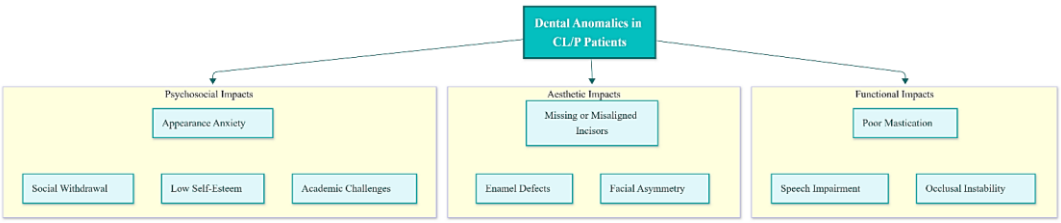

Figure 1. Flow chart illustrating the interrelation between dental anomalies in CL/P and their functional, aesthetic, and psychosocial impacts.

CONCLUSION

Dental anomalies in CL/P patients represent a multidimensional challenge, influencing mastication, speech articulation, occlusal stability, and facial esthetics while contributing significantly to psychosocial distress and diminished quality of life particularly during adolescence. Despite advances in surgical, orthodontic, and restorative care, complete functional and esthetic restoration remains elusive. Therefore, a long-term, integrated, multidisciplinary management model encompassing dental, surgical, speech, nutritional, and psychological domains is vital to achieve optimal rehabilitation and sustained well-being.

DECLARATIONS

Ethical Approval
Ethical approval was not required because this study was a narrative review of published literature and did not involve human/individual identifiable data.
Informed Consent
NA
Conflict of Interest
The authors declare no conflict of interest.
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Authors' Contributions
Concept: AR, UJ; Design: MEA, NA; Data Extraction: ZA, EA, ZM; Analysis: MH, AR; Drafting: AA, AR; Critical Revision/Final Approval: ARa.
Data Availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.
Acknowledgments
Not applicable.
Study Registration
Not applicable.

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