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Interceptive Orthodontic Strategy for Children with Cleft Lip and Palate: A Scoping Review of Appliances and Intervention Timing

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ABSTRACT

Cleft lip and/or palate (CLP) is a craniofacial congenital disorder causing upper jaw growth disorders, malocclusion, and functional/aesthetic impairments during childhood. Interceptive orthodontic strategies in children with cleft lip and palate: a scoping review of the tool and the timing of the intervention guide early dentofacial growth, yet tool types and timing vary widely, necessitating evidence mapping for clinical practice. This scoping review followed the PRISMA-ScR framework, searching PubMed and Scopus (2015–2025) for primary studies on interventional orthodontics in children with CLP. From 452 articles identified, 10 were included after screening and synthesis. Tools included presurgical nasoalveolar molding (PNAM), rapid maxillary expansion (RME), facemasks, and bone-anchored maxillary protraction (BAMP). Interventions ranged from neonatal to adolescent phases. BAMP yielded superior sagittal skeletal and facial profile corrections, especially pre-pubertal peak. Passive devices like NAM enhanced soft tissue repair and preoperative nasolabial symmetry. Interceptive orthodontics in CLP depends on device selection and timing; anchorage-based options like BAMP excel in active growth, while NAM suits presurgical aesthetics. These findings inform clinical decisions and future research in CLP orthodontic management.

Keywords: Lip cleft, cleft palate, child, orthodontic intercept, orthodontic appliances

INTRODUCTION

Cleft lip and/or Palate (CLP) is the most common congenital craniofacial disorder, with an incidence rate of about 1 in 500 live births globally (Markus et al., 2021). This disorder has long-term consequences, including maxillary growth disorders, skeletal malocclusion, speech difficulties, orophageal functional problems, and psychosocial stigma in childhood (Putri et al., 2023; Tobgyel et al., 2024; Ryu et al., 2021). One of the main problems in children with CLP is the appearance of progressive Class III malocclusion due to maxillary hypoplasia, so it requires orthodontic treatment from an early age (Defabianis et al., 2022).

Interventional orthodontic treatment aims to prevent or minimize occlusal and skeletal disorders before the child's growth is complete. Some commonly used approaches include Nasoalveolar Molding (NAM), Presurgical NAM (PNAM), Rapid Maxillary Expansion (RME), face mask protraction, and Bone-Anchored Maxillary Protraction (BAMP) (Chang et al., 2023; Ocak et al., 2024; Figueiredo et al., 2016; Faco et al., 2019). The interceptive strategy was carried out at various age stages, from neonatal to puberty, with clinical outcomes varying depending on the type of device and the time of intervention (Garib et al., 2020). However, until now there is no definite consensus on the best strategy for choosing the optimal tool and timing, especially in the child population with CLP (Cassi et al., 2017).

The limitations of the existing literature lie in the focus of studies that tend to assess one type of tool in retrospective designs or case reports with a small sample, without comparing the effectiveness between interventions as a whole (de Souza et al., 2020). In fact, the shift trend towards the use of anchorage skeletal devices and non-surgical approaches is increasingly being applied in modern orthodontic practice (American Academy of Pediatric Dentistry, 2022). On the other hand, clinical variation in the provision of orthodontic interventions in CLP

patients suggests a lack of structured evidence-based guidance, which could have implications for the long-term outcomes of children's maxillofacial development (Noverraz et al., 2015).

With these gaps, it is necessary to map scientific evidence through a scoping review that presents a comprehensive summary of the interventional orthodontic strategy, both in terms of the type of tool and the time of implementation. The results of this review are expected to contribute to evidence-based orthodontic clinical practice, as well as serve as a basis for further research and consistent clinical policymaking in CLP patients (Nakajima et al., 2023).

Based on this background, this review aims to explore and map a range of interventional orthodontic strategies in children with CLP, with a focus on the tools used as well as the timing of the intervention. The research question asked was: "What are the strategies of interreceptive orthodontics reviewed from the type of tools and intervention times (Concept) that have been applied to children with cleft lip and/or palate (Population) in the context of orthodontic clinical practice (Context)?"

RESEARCH METHOD

This scoping review was conducted based on a methodological framework established by the Joanna Briggs Institute (JBI) and reported in accordance with the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) checklist. This review protocol has been registered on the Open Science Framework (OSF) and can be accessed on https://osf.io/26zn3/ with registration number DOI: 10.17605/OSF. IO/ZKCQJ.

Eligibility criteria are established based on the PCC (Population, Concept, Context) framework. The focus population included children aged 0–18 years who were diagnosed with cleft lip and/or palate (CLP). The concept is focused on interceptive orthodontic strategies, including types of devices such as Nasoalveolar Molding (NAM), Rapid Maxillary Expansion (RME), face mask therapy, Bone-Anchored Maxillary Protraction (BAMP), and other maxillary traction appliances (Maxillary Protraction Appliances or MPA). The context includes clinical orthodontic interventions performed during the craniofacial growth period, without restrictions on geographic location or healthcare systems. Eligible studies must report on at least one of the following: timing of intervention implementation, dentoalveolar or skeletal effects, or treatment protocol. Only peer-reviewed articles published in English between January 2015 and March 2025 are included. Conference abstracts, theses, editorials and non-English publications are excluded to ensure the quality and clinical relevance of the evidence included.

The source of information includes two electronic databases: PubMed and Scopus. Additional manual searches were conducted through bibliographies of relevant studies and reviews. The last literature search was completed in June 2025. The search strategy is developed with Boolean Phrase Keywords. The search strings used in PubMed are as follows:

("orthodontic" OR "orthodontic treatment" OR "early orthodontic" OR "orthodontic intervention" OR "interceptive orthodontic" OR "orthopedic" OR "face mask" OR "facial mask" OR "maxillary protraction" OR "maxillary advancement" OR "nasoalveolar molding") AND ("cleft lip" OR "cleft palate" OR "cleft lip and palate" OR "CLP") AND ("child*" OR "children" OR "pediatric").

Filters are applied to limit results on English-language articles published between January 2015 and March 2025. A similar search strategy, with syntax and filter adjustments, is used in Scopus. The selection of studies is carried out in two stages. First, all citations obtained from the database are imported into Mendeley's reference management software, and duplicates are removed. Furthermore, the screening of titles and abstracts was carried out

independently by two reviewers. The full text of potentially eligible articles is accessed and evaluated based on pre-established inclusion criteria. Disagreements between the two reviewers were resolved through discussion and consensus without involving a third reviewer.

Data collection was carried out using a standard data extraction form that had been developed prior to the review process. Two reviewers extracted data independently and in pairs from all included studies. The data obtained is then cross-checked to ensure accuracy. If there are important data that is not available or unclear, the authors of the correspondence from the original study are contacted for clarification. The types of data collected include: author, year of publication, country, research destination, research design, sample and age, orthodontic devices, time and duration of intervention, main results/findings, conclusions. Risk bias in the scoping review methodology does not have to be carried out, but in this study a formal assessment of the risk of bias is still carried out. Relevant study characteristics such as sample count, presence of control groups, and prospective or retrospective design are noted to provide methodological context.

The results were analyzed descriptively using a narrative summary. Studies were categorized based on the type of tool, the time of implementation of the intervention, and the main outcomes/findings. Variations in treatment protocols as well as gaps in the evidence base were identified to provide direction for clinical practice and subsequent research priorities.

RESULTS AND DISCUSSION

A total of 452 articles were identified through systematic searches in two databases: PubMed (n = 115) and Scopus (n = 337). After the duplicate removal process, there are 109 unique articles that are then filtered by title and abstract. A total of 21 articles were selected for full-text assessment. Of these, 11 articles were issued for the following reasons: 5 were review articles, 4 were not relevant to the focus of the study, and 2 were not available in full-text form. Finally, 10 articles met the inclusion criteria and were included in the qualitative synthesis (Figure 1). The included studies were of a varied design, consisting of five cross-sectional studies, one randomized controlled trial (RCT), one cohort study, and three case reports. The studies came from various countries, including India, Brazil, Italy, Turkey, China, Japan, and the Netherlands. The study population consisted of children with different types of gaps (CLP, UCLP, BCLP, or incomplete UCLP), with an age range ranging from newborns to 19-year-old adolescents. Sample sizes varied between studies, ranging from one patient to 54 participants.

The characteristics of the included studies are summarized in Table 2. The studies included a variety of designs, namely case reports (n=3), cohort studies (n=1), retrospective/prospective studies (n=5), and one of them was a randomized clinical trial (n=1). The number of samples ranged from 1 to 54 patients, with an age range from neonates to 19 years. Based on PCC criteria; Population: children with cleft lip and/or palate (CLP), majority unilateral, Concept: interreceptive orthodontic strategies such as Nasoalveolar Molding (NAM), Rapid Maxillary Expansion (RME), Bone-Anchored Maxillary Protraction (BAMP), Fixed Appliances, and PNAM and Context: active growth phases, ranging from neonatal to adolescent. The follow-up period varies, from a few months to 7 years, depending on the type of intervention and the study design. References from all studies are available in Table 2.

Bias risk assessment is carried out according to the type of study: 1) Randomized clinical trials and prospective studies: assessed from the aspects of randomization, blinding, and completeness of data. The risk of bias is generally moderate to low. A common limitation

is the lack of operator blinding and small sample size. 2) Retrospective studies and case reports: have a high potential for selection bias due to a single subject and lack of control groups. Some studies also did not report fully on treatment methods or outcomes.

From the ten articles analyzed, the following findings were obtained: 1) Nasoalveolar Molding (NAM/PNAM): improves nasolabial symmetry, especially in early childhood, but is not significant to the transverse dimensions of the upper jaw (Ocak et al., 2024; Chang et al., 2023). 2) Rapid Maxillary Expansion (RME): provides dominant posterior expansion, with a greater dentoalveolar effect than skeletal. Both tools (Hyrax and iMini) are equally effective (Figueiredo et al., 2016). 3) Bone-Anchored Maxillary Protraction (BAMP): exhibits significant skeletal changes and potentially avoids the need for orthognathic surgery if performed during an active growth period (Faco et al., 2019; Garib et al., 2020). 4) Long-term nonsurgical approach: Provides stable occlusion and aesthetic results without additional surgery, especially when started early and performed gradually (Nakajima et al., 2023). 5) Case of dental transposition: shows that orthodontic biomechanical adaptations such as the use of premolars as a substitute for lateral incisives can provide good aesthetic and functional results (de Souza et al., 2020). 6) Infant orthopedics: showed no significant difference in the transverse relationship of the teeth at 9 and 12 years of age (Noverraz et al., 2015).

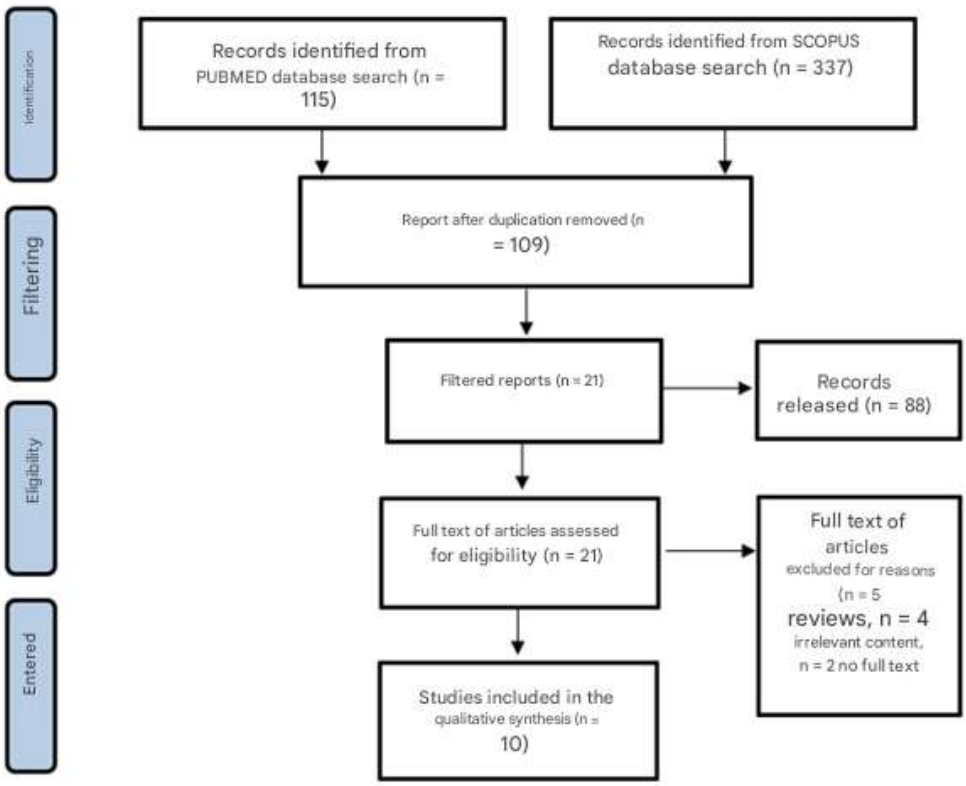

Figure 1. Prism Flow Diagram

Table 1. Bias Risk Assessment Using JBI Critical Assessment Tool

Study	Checklist 1	2	3	4	5	6	7	8	9	10	11	12	13	Assessment
Cross-Sectional Study														
Faco et al	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						Low Risk
Cassi et al	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						Low Risk
Ocak et al	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						Low Risk
Chang et al	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						Low Risk
Figueiredo et al	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						Low Risk
RCTs														
Noverraz et al	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low Risk
Cohort Study														
Sahoo, et al	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			Low Risk
Case-Report														
Nakajima et al	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						Low Risk
Souza et al	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						Low Risk
Garib et al	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						Low Risk

Table 2. Presentation of data analysis

No	Author (Year)	Country	Research Objectives	Research Design	Sample & Age	Orthodontic Tools	Time and Duration of Intervention	Key Results/Findings	Conclusion
1	Sahoo SS et al. (2023)	India	To evaluate the dental and skeletal effects of early orthodontic interventions on grade III malocclusion in children with and without CLP.	Longitudinal clinical studies	38 children (24L, 14P); 6-14 years. Group I (CLP): 18 children (10L, 8P), average age 8.89 + 1.60 years Group II (non-CLP): 20 children, average 8.70 + 1.87	Rapid Maxillary Expansion (RME) dengan Hyrax screw 11 mm + Reverse Pull Headgear (Delaire Type Face Mask)	Stage of mixed teeth; RME activation 2x/day for 7 days; Face mask use + 10-12 months, except when eating	2x/day for 7 days; the use of face masks + 10-12 months, except when eating Maksila is significantly more advanced in CLP children. The downward and posterior rotation of the mandibles is greater in CLP. SNA, ANB, and facial profiles improved significantly. Upper incisive proklination is higher in non-CLP. Upper molar extrusion is greater in CLP. The mandibles do not show significant changes in the direction of growth.	Expansion and protraction protocols successfully improved class III malocclusion in CLP and non-CLP children, with more pronounced effects on CLP. Long-term evaluation is recommended to assess the stability of the results.
2	Cassi D et al. (2017)	Italy	Investigating the effect of early	Longitudinal Retrospective Study	28 children (17L, 11P); age at TO:	Quad helix for transverse expansion	Early (<6 years) vs late (26 years):	Significant improvements in intercanine (4.7	Early orthodontic treatment is

No	Author (Year)	Country	Research Objectives	Research Design	Sample & Age	Orthodontic Tools	Time and Duration of Intervention	Key Results/Findings	Conclusion
			orthodontic treatment on the development of dental arches and alveolar bones in CLP patients.		average 6.5 + 1.7 years; age at T1: mean 9.2 + 2.1 years. Divided into 2 groups: Group A: < 6 years (n=12) Group B: > 6 years (n=16)	Delaire facial mask for maxillary protraction Detached or fixed device for correction of rotation and anterior crossbite	Early activation of quad helix 200 g per side, reactivation every 6 weeks Face mask 12 hours/day including night Average intervention duration of 2.7 years (TO-T1)	mm; p<0.001) and intermolar (5.3 mm; p<0.05) widths after treatment Huddart/Bodenham values increased (mean 4.6 points) Group A (<6 years) showed greater improvement than Group B, especially in the anterior region (intercaninus 8 mm vs 2.7 mm; p<0.001) and HB scores (7.1 VS 3; p<0.05)	effective in improving the maxillary transverse dimension and the relationship of the tooth's curve. Results are more favorable when started before the age of 6 years, especially in anterior expansion. However, long-term follow-up is needed to assess its long-term benefits and stability.
3	Faco R et al. (2019)	Brazil & Belgium	Evaluating skeletal and dentoalveolar cephalometric changes after treatment with Bone-Anchored Maxillary Protraction (BAMP) in UCLP patients.	Cohort Retrospective Study	25 patients with unilateral cleft lip and palate (UCLP) who had undergone secondary alveolar bone grafting; Average age at the start of treatment: 11.2*1.1 years. All patients are in a period of active growth.	Bone-Anchored Maxillary Protraction (BAMP): miniplate is attached to the zygoma and anterior bones of the mandibula, with #250 g/side intermaxillary elastic	Early / mixed teeth; after the transplant of the alveolar bone; Therapy lasted for 1 year on average with intermaxillary elastic use for >14 hours/day	Significant maxillary protraction (average 2.7 mm anterior and 1.3 mm to inferior) Increased ANB angle (+2.0°), indicating improvement in sagittal skeletal relationship No significant change in mandibular position or mandibular plane angle Minimal change in incisiveness and posterior occlusion Improvement of skeletal relationship without major	BAMP results in significant skeletal changes in UCLP patients, without mandibular rotation or excessive dentoalveolar changes. This technique

No	Author (Year)	Country	Research Objectives	Research Design	Sample & Age	Orthodontic Tools	Time and Duration of Intervention	Key Results/Findings	Conclusion
								dentoalveolar side effects	
4	Ocak et al. (2024)	Turkey	Evaluating the effect of NAM on upper jaw dimensions and malocclusion characteristics in first-tooth CLP patients.	Comparative retrospective studies	54 CLP patients (33 with NAM, 21 without NAM); age 4.7-6.0 years	Nasoalveolar molding (NAM)	Neonatal period before lip repair; Starting <10 days from birth to lip surgery (~3-4 months)	There was no significant difference in jaw arch width (intercanine & intermolar) between the NAM and non-NAM groups Anterior crossbite was more common in non-NAM (23.8%) than in NAM (12.1%) Slit type was more influential than NAM	NAM does not significantly affect the dimensions of the upper jaw or malocclusion; the type of gap (UCLP/BCLP) has a greater influence. Further studies are needed to assess the long-term effects of NAM.
5	Chang L et al. (2023)	China	To evaluate the effect of PNAM on jaw arch width and nasolabial symmetry on UCCLP.	Comparative retrospective studies	32 UCCLP patients aged 2-13 years; divided by age group and PNAM history	Presurgical nasoalveolar molding (PNAM)	Neonatal before primary cheiloplasty; Starts $4 weeks after birth	PNAM reduces the width of the anterior curve (canine-to-midline) PNAM improves nasal alar symmetry especially in children >7 years Lip symmetry increases in children <7 years Nostril side slits become shorter and wider after PNAM	PNAM provides aesthetic benefits (symmetry of the nose and lips), but may reduce the width of the anterior arch; The effects differ depending on the patient's age. There needs to be a balance between aesthetic benefits and long-term orthodontic risks.
6	Nakajima S et al. (2023)	Japan	Reporting results of long-term orthodontic care without additional surgery in	Case reports	1 male patient; 4-19 years	Lingual arch, Maxillary Protraction Appliance (MPA), Multi-	Mixed teeth: PSO from the age of 19 days, one-stage repair at the age of 5 months, MPA	PSO is effective in narrowing the gap between the alveolus and palate MPA is effective in correcting crossbite and promoting	One-stage repair at an early age, followed by gradual orthodontics (MPA,

No	Author (Year)	Country	Research Objectives	Research Design	Sample & Age	Orthodontic Tools	Time and Duration of Intervention	Key Results/Findings	Conclusion
			UCLP patients with one-stage repair.			bracket appliances	age 4-5 years, phase I bracket age 6-9 years, phase II age 11-16 years	maxillary growth No need for SABG or jaw osteotomy Long-term orthodontic treatment achieves stable occlusion although maxillary growth is still slightly less No need for transverse expansion due to good lateral growth	bracket), allows for good occlusion and aesthetic results without additional surgery. GPP contributes to bone bridging. This case supports a long-term nonsurgical orthodontic approach to CLP with time-appropriate modifications
7	Noverraz R et al. (2015)	Netherlands	Assessing the long-term effects of infant orthopedics on the tooth arch width of UCLP children aged 9 and 12 years.	Randomised clinical trials (RCTs)	54 UCLP children; divided into two groups (with and without infant orthopedics); Assessment Age: 9 and 12 years old	Infant Orthopedics (palatal plate)	Infants (0-1 years); Group 10 wore the device from week 1 to lip surgery at +18 weeks of age	There was no significant difference in the curved transverse relationship between the 10 and non-IO groups at 9 and 12 years of age Intercanine and intermolar width remained similar Molar and canine relationships tended towards the posterior crossbite in both groups	Infant orthopedics does not provide a long-term benefit to the transverse relationship of the tooth curve in UCLP children. Therefore, 10 clinical benefits in jaw width correction were not demonstrated in the long-term outcomes of this study.
8	Figueiredo D et al. (2016)	Brazil	Evaluate the skeletal and dentoalveolar effects of RME in CLP patients using two types of tools:	Prospective randomized clinical trials	20 patients; 8- 15 years old	Modified Hyrax dan iMini-Hyrax	Stage of mixed teeth; Activation 2x/day until intercuspid occlusion is achieved; retention 3	There is no significant change in the anteroposterior and vertical direction of the maxilla Significant transverse	Both are effective tools for maximal transverse expansion. Suitable for CLP patients with posterior

No	Author (Year)	Country	Research Objectives	Research Design	Sample & Age	Orthodontic Tools	Time and Duration of Intervention	Key Results/Findings	Conclusion
			modified Hyrax and inverted mini-Hyrax (iMini).				months prior to post-intervention CBCT evaluation	expansion occurs in the posterior greater than the anterior Symmetrical expansion between the slit and non-slit sides Greater movement in the crown than the root There is no significant difference in the degree of tipping between the two tools	discrepancy due to greater expansion in the posterior. Minimal orthopedic effects; Results are mainly dentoalveolar
9	de Souza R et al. (2020)	Brazil	Reporting unilateral CLP management with caninary-premolar tooth transposition and lateral incisive loss.	Case reports	1 patient; Starting at age 9	Quad-helix, fixed appliances, mini-implant for mesialization, secondary bone graft	After primary surgery (cheiloplasty/ti palatoplast); Slow expansion for 8 months, retention 12 months, bone graft for 11 years, fixed appliance for 12 years, maintenance for 7 years	Transposition is maintained and lateral incisive space is closed with premolar Quad-helix is effective for expansion Mini-implant helps posterior mesialization Stable results after 3 years of follow-up Aesthetics and anterior function are obtained, with premolar adaptation in the incisive position Root resorption is mild	Transposition acceptance and closure of the lateral incisive space with the premolar is an effective strategy in complex CLP cases, especially when tissue and bone conditions are supportive. This approach results in satisfactory long-term aesthetic and functional results.
10	Garib D et al. (2020)	Brazil	Reporting long-term outcomes of BAMP in UCLP adolescents with severe maxillary deficiency	Case reports	1 patient; Early age 12.4 years	Bollard miniplates (BAMP), fixed appliances, Class III elastics, transpalatal arch, biteplate	After SABG (starting at age 12.4 years); BAMP starts at 12.4 years old for 12 months with 250g Class III elastic, followed by	Overjet increased by 5.9 mm; SNA up 3.2o, SNB down 2.1o, ANB up 5.3o Significant improvement [facial rofil and intermaxillary relationship	BAMP therapy results in significant skeletal improvement and prevents the need for orthognathic surgery. Patient

No	Author (Year)	Country	Research Objectives	Research Design	Sample & Age	Orthodontic Tools	Time and Duration of Intervention	Key Results/Findings	Conclusion
						dengan spiring	42 months fixed appliance + night elastic until the end of the growth period	No surgery required Le Fort I Maxicular midline corrected with miniplate Aesthetics and occlusion stable until the end of growth - There are no significant side effects from wearing elastic at night	compliance is very influential. Active retention with nighttime elastic maintains stability. These results support the use of BAMP as an initial alternative in treating severe maxillary deficiency in UCLP patients.

This review identified and organized the scientific evidence related to the strategy of interceptive orthodontics in children with cleft lip and/or palate (CLP), based on the type of tool used and the timing of the intervention. Results showed that despite the diversity of methods, most interventions focused on maximal growth manipulation and skeletal relationship improvement, especially in the context of Class III malocclusion that is common in CLP patients (Luzzi et al., 2021). The certainty level of evidence from these studies varies according to study design, sample size, and evaluation methods.

The earliest strategy is carried out in the neonatal phase up to 3 months of age, usually with Nasoalveolar Molding (NAM) or Presurgical NAM (PNAM) devices. The goal is to position the alveolar segment and soft tissue to facilitate subsequent reconstructive surgery. Studies by Chang et al. (2023) and Ocak et al. (2024) show that NAM can improve nasolabial symmetry and reduce the width of the lip slit before surgery. However, its effect on transverse dimensions and long-term maxillary skeletal growth is relatively limited (Chang et al., 2023; Figueiredo et al., 2016). This evidence is in line with the findings of Rossi et al. (2021) who stated that although NAM improved initial aesthetic outcomes, there was no significant difference in long-term outcomes compared to conventional approaches.

After early age, the focus of the intervention shifted to upper jaw expansion through Rapid Maxillary Expansion (RME), with or without face mask protraction. This method aims to improve the transverse and sagittal connections of the jaw, while taking advantage of the child's growth potential. Figueiredo et al. (2016) found that RME resulted in a dominant, but more impactful posterior expansion of dentoalveolar than skeletal. The role of RME was also evaluated by Lee et al. (2016), who reported that the optimal time of expansion is before the peak of growth, as its effectiveness decreases after the puberty phase.

More aggressive approaches such as Bone-Anchored Maxillary Protraction (BAMP) using intraoral miniplate and class III elastic show promising results in improving skeletal contact without the need for orthognathic surgery (Faco et al., 2019; Garib et al., 2020). Studies by Faco et al. (2019) and Garib et al. (2020) state that BAMP can significantly improve SNA, SNB, and ANB and provide a positive effect on facial profiles. These findings are reinforced by Luzzi et al. (2021) and Rossi et al. (2021) who used a three-dimensional evaluation to assess the effectiveness of skeletal protraction anchorage, with results in increased anterior maxillary growth and occlusion improvement. This method is considered more stable in the long term than conventional face masks.

Meanwhile, a long-term non-surgical approach that relies on orthodontic biomechanical adaptation is also a relevant strategy. For example, de Souza et al. (2020) showed that canine and premolar transposition can be treated with control of tooth movement through mini-implants and functional tools, resulting in stable occlusion even without lateral incisive surgical repositioning. In a case study by Nakajima et al. (2023), CLP patients who underwent early-stage cheilopalatoplasty then received gradual orthodontics into adulthood, showing satisfactory aesthetic and functional results without secondary surgery. This shows the potential for successful conservative orthodontic management when done within a time frame and structured planning.

However, the effectiveness of orthodontic interventions is influenced not only by the type of device, but also by the time of implementation. Defabianis et al. (2022) stated that interceptive orthodontic interventions performed at ages before 8–10 years of age were associated with more skeletal and dentoalveolar outcomes. This underscores the importance of planning treatment time based on the child's growth phase.

However, the results of existing studies still need to be interpreted with caution given the high level of methodological heterogeneity. Most studies used a case report or case series design without a control group, with large variations in duration, measurement methods, and tools used (Chang et al., 2023; Ocak et al., 2024; Cassi et al., 2017). In addition, the risk of selection bias is quite high, especially in studies with a single sample or retrospective. Among the studies that reported objective results with cephalometric analysis tools or CBCT, only a small percentage included long-term follow-up to the end of growth (Nakajima et al., 2023).

Another factor to consider is the psychosocial impact and patient compliance, which play an important role in long-term success. Arcila et al. (2023) emphasize the importance of measuring outcomes from a patient's perspective, including aesthetic perception, pain, and quality of life. Unfortunately, few studies have evaluated such parameters in the context of interventional orthodontic interventions on CLP. Tsichlaki et al. (2017) suggest the need for multidisciplinary team management to maximize clinical and psychosocial outcomes, which is in line with practice in large craniofacial service centers.

The limitations of this review include the absence of meta-analysis due to the limitations of quantitative data and the high variability of study design. In addition, not all articles included detailed information regarding intervention methods, effect sizes, or consistent risk evaluation of bias. Future research should use randomized controlled clinical trial (RCT) designs, large sample sizes, and longitudinal analysis methods to thoroughly evaluate clinical and functional outcomes (Lee et al., 2016; Arcila et al., 2023). It is also

important to consider the integration of biological, biomechanical, and psychosocial aspects in the preparation of orthodontic intervention protocols for children with CLP.

CONCLUSION

This scoping review maps interceptive orthodontic strategies for children with cleft lip and/or palate (CLP), focusing on device types and intervention timing. Findings indicate that early interventions, especially pre-puberty, yield superior outcomes in correcting skeletal relationships and occlusion stability, with skeletal anchorage-based tools like bone-anchored maxillary protraction (BAMP) demonstrating greater corrective potential than passive options such as nasoalveolar molding (NAM) or infant orthopedic plates. By systematically mapping evidence, the study addresses variations in approaches and optimal timing, providing structured information to guide clinical decisions and practice guidelines for CLP management. Future research should conduct randomized controlled trials comparing long-term stability and cost-effectiveness of BAMP versus passive tools across diverse CLP severities and ethnic groups.

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