Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 13s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Timing And Sequencing Of Orthognathic Procedures In Adolescent Patients: A Systematic Review

Vivek Agarwal[1], Mayukh Mishra[2], Debapratim Jana[3], Jaydeep Samanta[4], Chirantan Maity[5], Anirban Banerjee[6]

[1]Professor, Department of Orthodontics & Dentofacial Orthopaedics, Haldia Institute of Dental Sciences & Research, Haldia, West Bengal, India. Email ID: drvivekagarwal@gmail.com

[2]Professor, Department of Oral & Maxillofacial Surgery, Haldia Institute of Dental Sciences & Research, Haldia, West Bengal, India. Email ID: drmayukh@gmail.com

[3]Reader, Department of Orthodontics & Dentofacial Orthopaedics, Haldia Institute of Dental Sciences & Research, Haldia, West Bengal, India. Email ID: debhidsar@gmail.com

[4]Reader, Department of Orthodontics & Dentofacial Orthopaedics, Haldia Institute of Dental Sciences & Research, Haldia, West Bengal, India. Email ID: jaydeep2006j@yahoo.co.in

[5]Reader, Department of Oral & Maxillofacial Surgery, Haldia Institute of Dental Sciences & Research, Haldia, West Bengal, India. Email ID: cheerantan@gmail.com

[6]Senior Lecturer, Department of Orthodontics & Dentofacial Orthopaedics, Haldia Institute of Dental Sciences & Research, Haldia, West Bengal, India. Email ID: banerjee.anirban1795@gmail.com

***Corresponding Author:**

Vivek Agarwal,

Email ID: drvivekagarwal@gmail.com

Cite this paper as: Vivek Agarwal, Mayukh Mishra, Debapratim Jana, Jaydeep Samanta, Chirantan Maity, Anirban Banerjee, (2025) Timing And Sequencing Of Orthognathic Procedures In Adolescent Patients: A Systematic Review. *Journal of Neonatal Surgery*, 14 (13s), 432-443.

ABSTRACT

Orthognathic surgery in adolescent patients aims to correct severe dentofacial deformities and improve both function and aesthetics. The timing and sequencing of these procedures are critical factors that influence the outcome and long-term stability. Early intervention may be beneficial for skeletal maturity and long-term results, though careful consideration of the patient's growth potential is crucial. This systematic review examines existing literature on the timing and sequencing of orthognathic procedures in adolescent patients, with a focus on the appropriate age for surgery, the sequence of surgical intervention, and the impact on facial growth and development. The review also addresses the impact of different surgical sequences, such as maxilla-first or mandible-first approaches, and highlights the role of orthodontic preparation in achieving optimal outcomes. Based on the analysis, the review provides recommendations for clinicians on how to time and sequence orthognathic procedures to achieve the best functional and aesthetic results for adolescent patients.

Keywords: *Adolescent patients, Facial aesthetics, Orthognathic surgery, Surgical planning, Skeletal deformities, Timing of surgery*

1. INTRODUCTION

Orthognathic surgery plays an essential role in treating adolescents with significant dentofacial deformities, which can affect both facial function and aesthetics. These surgeries involve repositioning the maxilla and mandible to correct skeletal malocclusions and enhance facial harmony. The timing and sequencing of these procedures are critical factors influencing

important consideration. Techniques such as maxilla-first or mandible-first approaches have distinct benefits and challenges, with the sequence impacting surgical outcomes, recovery times, and long-term stability [3]. Managing adolescents with severe dentofacial anomalies presents a unique challenge for both oral and maxillofacial surgeons and orthodontists, particularly due to the limited research available on the timing of these surgeries and their effects on craniofacial development [4]. As a result, orthognathic surgery is often considered only after growth has been completed. However, in some cases, delaying surgery can lead to functional or aesthetic concerns, especially when early intervention is necessary for psychosocial

reasons [5]. Facial appearance plays a significant role in interpersonal relationships, making it essential to address these issues when needed [6]. A comprehensive understanding of normal craniofacial growth is essential for determining the optimal timing for orthognathic surgery [7]. The development of the maxilla in terms of vertical, sagittal, and transversal dimensions varies, with different peaks and final stages of growth [8]. Surgical techniques employed in orthognathic procedures can also allow for the management of maxillofacial growth axes in specific cases. Thus, a thorough evaluation of each patient's craniofacial growth stage is necessary to make an accurate diagnosis and establish the most suitable timing for surgical intervention [9].This systematic review aims to examine existing researches on the timing and sequencing of orthognathic surgery in adolescent patients and the objective is to provide evidence-based recommendations to clinicians on how to plan these surgeries effectively, ensuring the best possible functional and aesthetic outcomes. Through this detailed analysis of indications and limitations, the review seeks to define, justify, and standardize the optimal timing for surgical intervention in cases of dentofacial deformities [10].

2. RESEARCH METHODOLOGY

Research Design

Within the framework of this systematic review, a qualitative study approach was utilized, and a full examination of the current literature about the timing and sequencing of orthognathic surgeries in adolescents was incorporated. In this study, a descriptive and comparative approach is taken to analyze several surgical techniques, the timing of those approaches, and the influence those methodologies have on facial growth.

Data Collection Methods

A systematic search of the existing body of literature was carried out with the assistance of various online databases, including PubMed, Scopus, Web of Science, and Google Scholar. Journal papers that had been subjected to peer review, clinical trials, retrospective investigations, and meta-analyses that had been published over the past twenty years (2003–2023) were all included in the search. The following keywords and Boolean operators were utilized in order to restrict the search: "Orthodontic surgery" AND "adolescent patients," "Surgery-first approach" AND "facial aesthetics," "Surgical sequencing" AND "skeletal deformities," "Timing of surgery" AND "postoperative outcomes," and "postoperative outcomes."

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Studies published in English.
- Articles focusing on adolescent patients (10–19 years) undergoing orthognathic surgery.
- Research discussing surgical sequencing methods (surgery-first, surgery-early, surgery-late).
- Studies evaluating functional, aesthetic, and orthodontic outcomes.

Exclusion Criteria:

- Studies focusing solely on adult patients
- Case reports and opinion-based articles without empirical data
- Studies without clear documentation of methodology

Data Extraction and Synthesis

The studies that were chosen were evaluated to determine their relevance and credibility. Included in the process of data extraction were the following: study design (randomized control trials, retrospective studies, meta-analyses, case series, etc.), sample size and demographic details, type of surgical approach (surgery-first, surgery-early, or surgery-late), postoperative outcomes (functional stability, aesthetic improvements, and orthodontic efficiency), complications, and long-term follow-up results. Synthesizing the retrieved data through the use of a thematic analysis technique allowed for the categorization of the findings into significant topics such as the timing of intervention, sequencing tactics, surgical outcomes, and orthodontic integration.

Quality Assessment

The standards established by PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) were utilized in order to evaluate the quality of the papers that were chosen specifically. For the purpose of assessing the potential for bias, the Cochrane Risk of Bias Tool was utilized for clinical trials, whereas the Newcastle-Ottawa Scale was utilized for observational research. In this study, we conducted an in-depth analysis of a number of factors, including sample selection, study blinding, and data completeness.

Data Analysis

For the purpose of contrasting the various surgical sequencing approaches, a qualitative synthesis was carried out. Statistical methods such as RevMan (Review Manager) were utilized in order to evaluate effect sizes and confidence intervals in the context of meta-analysis, which was carried out in situations where there was an adequate amount of quantitative data available.

Ethical Considerations

Considering that this is a systematic review, no human nor animal participants were directly involved in the research. On the other hand, ethical standards were maintained by ensuring that sources were cited accurately, avoiding the falsification of data, and sticking to publication norms.

Limitations of the Study

- Variability in study designs and methodologies among selected articles
- Limited availability of long-term follow-up data for adolescent patients
- Potential publication bias in favor of positive surgical outcomes

Prisma flowchart of study is seen in [**Figure 1]**

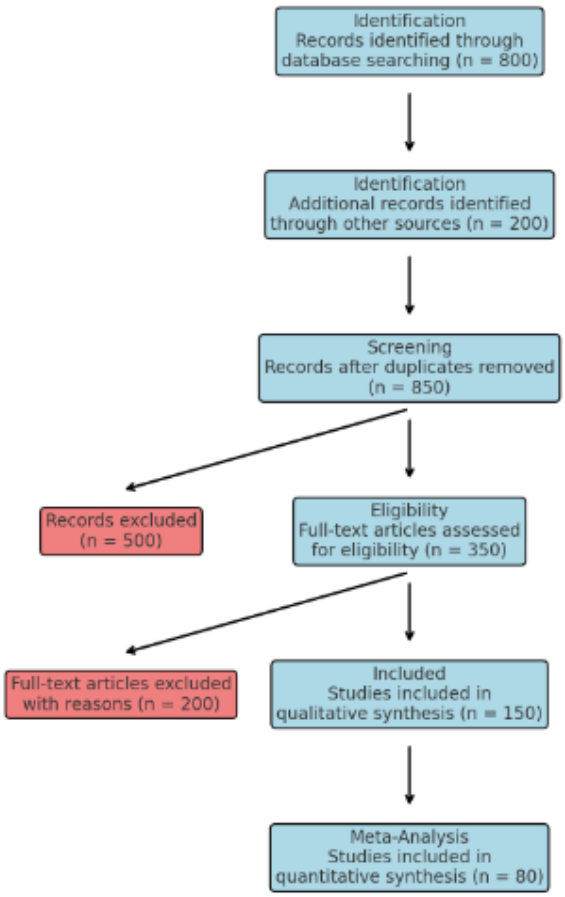

Figure 1: Prisma flowchart of the study

Discussion: Over the past decade, there is a significant reevaluation of treatment approaches in orthognathic surgery. Specifically, the traditional method—comprising a variable period of preoperative orthodontic treatment, surgery, and a stable phase of postoperative orthodontics—evolves [11]. A newer trend known as the "surgery first" approach, which involves performing the surgical intervention before starting orthodontic treatment, gains traction among oral and maxillofacial surgeons as well as orthodontists [12]. Several factors contribute to its popularity. First, by addressing skeletal issues, which are often the primary aesthetic concerns for patients, early in the process, the surgery-first approach ensures that these concerns are resolved from the outset. This positively impacts patient compliance with postoperative orthodontics

and contributes significantly to overall satisfaction with the treatment [13]. Second, this approach significantly reduces the total time spent on orthodontic treatment. The improvement in orthodontic efficiency is likely due to the regional acceleratory phenomenon, where the operated bones temporarily undergo demineralization, enhancing orthodontic progress [14]. Additionally, the corrected skeletal position minimizes soft tissue imbalances that could otherwise hinder orthodontic movements [15]. Third, when compared to the traditional sequence of orthodontics, surgery, and orthodontics, the surgery-first approach does not negatively affect the final occlusal outcome, and satisfaction from both orthodontists and patients is comparable to that seen with the conventional method. Over time, it becomes clear that many patients do not fit strictly into one approach or the other, with some undergoing surgery at different stages in the orthodontic treatment process [16].

Surgery First Approach:

This approach begins with the surgical procedure, followed by regular postoperative orthodontics. It is typically used for patients with skeletal malocclusions that require both orthodontic and surgical intervention, but without the need for extractions [17]. The main reasons for choosing this method include aesthetic concerns or issues such as sleep-disordered breathing [18]. Patients are carefully selected, and orthodontic management is handled by a qualified orthodontist with experience in orthognathic surgery. Exclusion criteria include severe crowding requiring extractions, significant asymmetry with three-dimensional (3D) dental compensations, maxillary hypoplasia needing surgically-assisted rapid palatal expansion, or any underlying temporomandibular joint disorders [19]. Virtual planning is used to simulate both the osteotomies and the necessary orthodontic movements. Brackets are placed one week before surgery, and no arch wires are applied until shortly before or after surgery to ensure that the surgical outcome is not compromised. Corticotomies are also performed to speed up orthodontic movement through the regional acceleratory phenomenon. Orthodontic treatment begins in the second postoperative week, with archwires changed every 2-3 weeks [20].

Surgery Early Approach:

This method is used for patients who do not fully meet the criteria for surgery-first but still seek early aesthetic improvement. These patients often have severe crowding or complex dental compensations due to facial asymmetry. In these cases, orthodontic preparation, such as managing crowding through extractions, is required before surgery. After sufficient space closure, surgery is performed. Like the surgery-first approach, virtual planning and 3D orthodontic setups are used. Corticotomies are performed during surgery to enhance post-operative orthodontic movement, and orthodontic treatment begins two weeks after surgery [21].

Surgery Late Approach:

The traditional "surgery-later" approach follows the standard sequence of preoperative orthodontics, surgery, and postoperative orthodontics. This method is chosen for patients who do not meet the criteria for either surgery-first or surgery-early, or those whose primary motivation is achieving optimal occlusion rather than aesthetic concerns. Patients typically undergo orthodontic treatment to level and decompensate the arches, followed by surgery. Miniscrews are not routinely used, and corticotomies are not performed unless necessary [22].

Surgery Last Approach:

This approach is designed for patients who have already undergone orthodontic treatment but later decide they need surgery. These patients typically present a stable occlusion and are mainly seeking aesthetic improvements while maintaining their preoperative maxillomandibular relationship. Bimaxillary surgery is typically performed with rotations to improve facial aesthetics. No corticotomies are needed, as no further major dental movements are anticipated [23].

Surgery Only Approach:

The surgery-only approach skips any prior or subsequent orthodontic treatment. It is indicated for patients with specific concerns, such as aesthetic issues, sleep-disordered breathing, or those with edentulism who do not require orthodontic alignment. Surgery is focused on achieving functional or aesthetic improvements without orthodontics, often involving procedures to improve the airway in patients with obstructive sleep apnea. No corticotomies are performed, and the focus is on maintaining the occlusion [24].

Surgery Never Approach:

This category includes patients who opt out of orthognathic surgery entirely. Typically, these are patients with occlusal concerns or a fear of surgery, who prefer to pursue orthodontic treatment exclusively [25].

For all six approaches, variables such as gender, age, chief complaint, treatment length, and the number of orthodontic appointments are considered. Older patients tend to choose the surgery-last or surgery-only options [26]. Patients undergoing surgery-first, surgery-early, or surgery-late generally have a main goal of improving facial aesthetics, while those choosing the surgery-late approach focus on optimizing occlusion. Compared to surgery-early and surgery-first, the surgery-late option requires an average of 38 to 52 more weeks of orthodontic treatment, but the total number of orthodontic appointments is similar for all timing categories [27]. [**Table 1**] presents each of these approaches presents different advantages and

challenges, with the choice of method heavily dependent on patient-specific needs, concerns, and goals.

Table 1: Patient-Specific Approaches: Advantages, Challenges, and Considerations

Approach	**Patient Selection Criteria**	**Preoperative Orthodontic Treatment**	**Surgical Timing**	**Postoperative Orthodontics**	**Key Benefits**	**Challenges**	**Literature Review**
Surgery First	Skeletal malocclusion requiring surgery without extractions. Aesthetic concerns, sleep-disordered breathing, etc.	None (or minimal bracket bonding only)	Surgery performed before orthodontic treatment	Postoperative orthodontics begins 1-2 weeks after surgery. Arch wires are changed every 2-3 weeks.	1. Immediate skeletal correction improves aesthetics. 2. Shorter overall orthodontic treatment time. 3. Regional acceleratory phenomenon accelerates post-operative orthodontics.	1. Potential for less control over dental movements post-surgery. 2. Need for careful selection of patients.	Several studies confirm high patient satisfaction with improved aesthetics and reduced treatment time (Lee et al., 2008) [28]. Positive outcomes for skeletal corrections and occlusal stability
Surgery Early	Severe crowding, complex 3D dental compensations, dental midline deviations. Must meet some criteria for surgery first.	Orthodontic treatment for crowding/extraction space closure	Surgery after managing severe crowding or transverse compensations	Postoperative orthodontics starts 2 weeks post-surgery, similar to surgery first.	1. Combines benefits of early skeletal correction with manageable orthodontic preparation. 2. Similar Regional acceleratory phenomenon benefits.	1. Longer preoperative treatment period than surgery first. 2. More complex cases to manage.	This approach shows positive outcomes in reducing overall treatment duration and enhancing skeletal correction (Takeshita et al., 2024) [29]. Typically results in acceptable aesthetic and functional

							outcomes.
Surgery Late	Standard occlusal corrections. Main motivation is achieving optimal occlusion (compared to aesthetic improvements).	Full preoperative orthodontic preparation for arch leveling and decompensation	Surgery after significant orthodontic preparation	Postoperative orthodontics continues after surgery for final occlusal adjustments.	1. Standard approach with a focus on occlusion. 2. Well-established procedure with predictable results.	1. Long treatment duration due to pre- and postoperative orthodontics. 2. More appointments and potential discomfort.	Literature suggests this approach is highly predictable and results in good occlusion but requires longer treatment time (Proffit et al., 2019) [30].It's the most traditional approach with proven long-term success.
Surgery Last	Patients with a compensated, stable occlusion seeking aesthetic improvement but maintaining preoperative skeletal relationship.	Pre operative orthodontic treatment is performed.	Surgery is performed after orthodontics in a compensated occlusion.	Limited postoperative orthodontics focused on refinement.	1. Focus on aesthetic enhancement. 2. No significant occlusal changes needed, hence limited orthodontic post-surgery.	1. Limited improvement in occlusion for some patients. 2. Not suitable for all types of deformities.	Commonly used for patients with stable occlusion who desire only aesthetic changes (Tanaka et al., 2020) [31]. Generally successful for minor occlusal adjustments
Surgery Only	Aesthetic concerns or functional issues (e.g., sleep apnea). No	None	Direct surgery, no prior orthodontic treatment.	No orthodontic treatment post-surgery.	1. Quick resolution of aesthetic or functional	1. Limited to very specific cases. 2. May not achieve	This method is effective in certain cases (i.e.,

	orthodontic need.				issues (e.g., sleep apnea). 2. No orthodontic involvement simplifies treatment.	optimal occlusion.	sleep apnea or purely aesthetic patients) but is not widely used for occlusal issues (Gupta et al., 2025) [32]. Limited long-term outcomes available due to narrow patient selection.
Surgery Never	Occlusal concerns or fear of surgery. No intention for orthognathic surgery.	Full orthodontic treatment.	No surgery; patients only undergo orthodontic treatment.	Continued orthodontics without surgical intervention.	1. Non-invasive. 2. Only for patients with occlusal issues, no skeletal deformities.	1. May not address underlying skeletal deformities. 2. Limited in resolving aesthetic concerns.	Literature suggests that surgery never is only viable for mild occlusal concerns and does not address skeletal deformities (Gungor et al., 2019) [33]. Often results in suboptimal long-term outcomes for more severe cases.

Over the past five decades, both the orthodontic and surgical fields have seen significant advancements in the treatment of dento-maxillofacial deformities. In surgery, the development of rigid fixation systems and other technical innovations has

led to minimally invasive surgical methods [34]. The adoption of hypotensive anesthesia, which helps minimize bleeding and swelling, has made orthognathic surgery safer and more reliable, with many procedures now being performed on an outpatient basis [35]. In orthodontics, the introduction of temporary anchorage devices has increased anchorage options, enhancing treatment efficiency and reducing treatment times. The typical profile of a patient undergoing orthognathic surgery has changed. Initially, the primary objective was to correct a functional occlusion, but today, many patients seek surgery for aesthetic reasons [36]. This shift, coupled with the growing perception of surgery as a safe and predictable option, has led to an increase in adult patients seeking orthodontic or combined orthodontic-surgical treatment [37]. Many of these patients have issues such as periodontal concerns or limited time for long treatments. Some adults are dissatisfied with their aesthetic outcomes despite undergoing orthodontic compensation, while others have sleep-disordered breathing or obstructive sleep apnea and require airway expansion and maxilla-mandibular advancement. These patients often prefer or are unable to undergo extensive orthodontic preparation before surgery. These changes in patient profiles have led to a reassessment of the traditional timing for orthognathic surgery, with new treatment approaches now available [38]. Surgery timing is no longer seen as simply a choice between traditional and surgery-first methods. There are now six potential approaches: (1) 'surgery first,' (2) 'surgery early,' (3) 'surgery late,' (4) 'surgery last,' (5) 'surgery only,' and (6) 'surgery never.' In the 'surgery first' approach, surgery is performed without prior orthodontic preparation [39]. One study found that the average treatment time for the 'surgery late' approach was 97.5 weeks, more than twice as long as the 45.3 weeks required for the 'surgery first' protocol, even though the frequency of orthodontic appointments was similar for both methods for 'surgery late' vs. for 'surgery first' [40]. This reduction in treatment time is attributed to the surgically induced regional acceleratory phenomenon, which speeds up orthodontic treatment once skeletal correction is achieved [41]. About 18.8% of cases benefit from the 'surgery first' approach, but careful patient selection is essential. Ideal candidates include those motivated by aesthetic goals or those with sleep-disordered breathing. However, patients who require perfect occlusion or have severe crowding, significant dental compensations, or Class II second division with overbite should not undergo this approach [42]. Additionally, patients with temporomandibular joint issues or uncontrolled periodontal disease are excluded due to the risk of post-surgical occlusal instability and complications with orthodontic movements [43]. Preoperative 3D virtual orthodontic setups are essential for accurately predicting future dental movements, and orthodontists need expertise in managing temporary anchorage devices and frequent follow-ups. One of the main benefits of the 'surgery first' approach is that patients can schedule surgery at their convenience without waiting for complete orthodontic preparation. This is especially beneficial for skeletal Class III patients, where orthodontic preparation often worsens facial appearance. Moreover, these patients tend to exhibit better compliance with postoperative orthodontic treatment, leading to higher overall satisfaction with the results [44]. However, patients with more complex dental issues—such as severe crowding, dental compensations, or logistical constraints—may benefit more from the 'surgery early' approach. This method involves a brief period of orthodontic treatment before surgery [45]. Despite the advantages of the 'surgery first' and 'surgery early' approaches, the 'surgery late' method, also known as conventional timing, remains the most commonly used (72.1%) [46]. This approach involves two phases of orthodontic treatment: a preoperative phase aimed at achieving a decompensated, leveled occlusion, followed by a postoperative phase for minor adjustments. Preoperative orthodontic treatment typically lasts 15 to 17 months, sometimes extending up to 24 months, with an additional 7 to 12 months for the postoperative phase [46]. While treatment may take longer than initially expected, the 'surgery late' approach remains predictable and effective, particularly for cases that require precise occlusal adjustments involving complex 3D dental movements [47]. A smaller group of patients may follow the 'surgery last' approach, initially rejecting surgery but later opting for skeletal correction after orthodontic treatment. These patients are typically older and have more periodontal concerns. If their occlusion remains stable and functional, no further orthodontic treatment is needed, and the surgical procedure focuses on correcting facial imbalance by rotating the maxillomandibular complex. This approach helps restore facial harmony while preserving the preoperative occlusion [48].The 'surgery only' option is suited for patients with stable occlusion who have facial aesthetic concerns but no prior orthodontic treatment. It is also appropriate for edentulous patients who do not benefit from orthodontic treatment or for those with obstructive sleep apnea who need airway expansion. In these cases, the surgery focuses on adjusting the rotational and translational movements of the maxillomandibular complex, with no need for postoperative orthodontics [50]. Finally, the 'surgery never' approach is for patients who choose not to undergo surgery and opt for orthodontic compensation instead. While this approach can yield a stable, functional occlusion, it requires the orthodontist to be highly skilled to prevent relapse and minimize the risk of periodontal complications. Ultimately, the timing of orthognathic surgery should be personalized based on each patient’s needs, expectations, and clinical circumstances. The decision-making process should take into account the patient’s motivations, the complexity of orthodontic and surgical management, and the expertise of both the orthodontist and the surgeon [51].

3. FUTURE PROSPECTS

The timing and sequencing of orthognathic procedures in adolescent patients have evolved significantly, with increasing awareness of both the functional and aesthetic outcomes associated with these interventions. The future of orthognathic surgery and orthodontic treatment in adolescents presents numerous opportunities for improvement and refinement, including advancements in surgical techniques, digital technologies, patient-specific planning, and more personalized treatment protocols. Below are several key areas where progress is expected:

1. **Advancements in Surgical Techniques and Minimally Invasive Approaches:** Future

developments in surgical techniques, particularly minimally invasive approaches, could play a crucial role in improving patient outcomes and reducing recovery times for adolescent patients. As technology advances, the integration of robotic-assisted surgery or more refined tools for precise bone cuts and repositioning will likely become standard practice, allowing for more predictable results with less morbidity. The possibility of performing certain aspects of surgery with even fewer incisions, reduced trauma, and improved postoperative recovery could significantly enhance the quality of life for adolescent patients [52].

2. **Enhanced Digital Planning and Virtual Simulation:** The increasing integration of digital technologies, such as 3D imaging, virtual reality, and computer-aided design, allows for more accurate preoperative planning. Through these technologies, orthodontists and surgeons can create a detailed, patient-specific model of the craniofacial structures and simulate the effects of surgery before the procedure. This allows for a more personalized approach, predicting not only functional outcomes but also aesthetic ones. Over time, artificial intelligence algorithms may further improve virtual surgical planning, offering real-time decision-making support and optimizing treatment sequences based on patient-specific needs.
3. **Patient-Specific Timing Protocols:** One of the key future directions in orthognathic treatment is the development of more personalized, patient-specific protocols for treatment timing and sequencing. This could include an increased focus on genetic, skeletal, and dental maturation, allowing for more customized recommendations about the optimal timing of surgery and orthodontic treatment. For example, the use of biomarkers or advanced imaging techniques might provide insights into the most advantageous time to intervene based on individual growth patterns. By tailoring treatment plans to each adolescent's unique growth trajectory, the risk of complications could be minimized, and treatment outcomes could be enhanced [53].
4. **Integration of Non-Surgical Options:** There is growing interest in exploring non-surgical alternatives or adjuncts to traditional orthognathic surgery in adolescents. Techniques such as dental and skeletal distractors, functional appliances, and the use of temporary anchorage devices may increasingly be used to modify skeletal and dental structures without the need for extensive surgery. Ongoing research into the efficacy of such non-invasive or minimally invasive treatments could significantly reduce the need for surgery, leading to shorter treatment timelines and fewer potential complications for adolescent patients.
5. **Long-Term Outcome Studies:** With the increasing complexity of treatment options available, there will be a greater emphasis on long-term outcome studies to evaluate the effectiveness and stability of different timing and sequencing approaches. More robust, evidence-based data will be needed to establish the most successful treatment strategies for adolescent patients and to refine recommendations for specific cases. These studies could help define the best protocols for maintaining facial harmony and functional occlusion over time, ensuring that patients achieve optimal outcomes well into adulthood.
6. **Psychosocial and Quality of Life Considerations:** As more adolescents undergo orthodontic or combined orthodontic-surgical treatment, the psychosocial aspects of treatment will gain importance. Future research may focus more on the emotional, psychological, and social impact of early intervention, helping to guide clinicians in providing more holistic care. Understanding the mental and emotional effects of treatment, particularly the aesthetic changes associated with orthognathic procedures, could lead to the development of support programs that better prepare adolescents for the challenges of undergoing these procedures.
7. **Collaborative Decision-Making and Multidisciplinary Approaches:** Future advancements will likely see even greater collaboration among orthodontists, surgeons, psychologists, and other healthcare providers. Multidisciplinary treatment planning could ensure that all aspects of the adolescent's development—both physical and emotional—are considered when determining the optimal timing and sequencing of orthognathic surgery. This holistic approach may lead to improved treatment satisfaction, better long-term outcomes, and reduced complications, as all stakeholders contribute to the decision-making process.
8. **Improved Orthodontic Mechanisms for Faster Treatment:** The development of new orthodontic technologies, such as self-ligating braces, clear aligners, and accelerated tooth movement systems, will play a significant role in shortening treatment times and improving the overall efficiency of orthodontic care. These innovations may allow for quicker realignment of the teeth and better integration with the surgical phase of treatment. This means that adolescents may be able to undergo less invasive and shorter treatments without sacrificing functional or aesthetic outcomes [54].

4. CONCLUSION

This systematic review highlights the varying approaches to the timing and sequencing of orthognathic procedures in

adolescent patients, reflecting a shift towards more individualized treatment strategies. Both traditional and newer methods, including the surgery-first approach, offer distinct benefits and challenges, with the choice largely dependent on patient-specific factors such as skeletal deformities, aesthetic concerns, and orthodontic needs. The evidence suggests that early intervention can lead to improved outcomes in terms of both aesthetic and functional results, although the decision regarding the optimal timing should be made on a case-by-case basis. Further long-term studies are needed to better assess the effectiveness and risks of different sequencing strategies and to determine the most beneficial approach for different subgroups of adolescent patients. Ultimately, personalized care and careful multidisciplinary planning remain crucial in optimizing treatment outcomes for this population.

Financial support and sponsorship Nil

Conflicts of interest There are no conflicts of interest

REFERENCES

[1] Hernández-Alfaro F, Guijarro-Martínez R, Molina-Coral A, Badia-Escriche C. ‘‘Surgery first’’ in bimaxillary orthognathic surgery. J Oral Maxillofac Surg. 2011; 69(6):e201–7.

[2] Liou EJ, Chen PH, Wang YC, Yu CC, Huang CS, Chen YR. Surgery-first accelerated orthognathic surgery: postoperative rapid orthodontic tooth movement. J Oral Maxillofac Surg. 2011; 69(3):781–5.

[3] Nagasaka H, Sugawara J, Kawamura H, Nanda R. ‘‘Surgery first’’ skeletal class III correction using the Skeletal Anchorage System. J Clin Orthod. 2009; 43(2):97–105.

[4] Sugawara J, Aymach Z, Nagasaka DH, Kawamura H, Nanda R. ‘‘Surgery first’’ orthognathics to correct a skeletal class II malocclusion with an impinging bite. J Clin Orthod. 2010; 44(7):429–38.

[5] Chemello PD, Wolford LM, Buschang PH. Occlusal plane alteration in orthognathic surgery—part II: long-term stability of results. Am J Orthod Dentofacial Orthop. 1994; 106(4):434–40.

[6] Villegas C, Janakiraman N, Uribe F, Nanda R. Rotation of the maxillomandibular complex to enhance esthetics using a ‘‘surgery first’’ approach. J Clin Orthod. 2012; 46(2):85–91; quiz 123.

[7] Villegas C, Uribe F, Sugawara J, Nanda R. Expedited correction of significant dentofacial asymmetry using a ‘‘surgery first’’ approach. J Clin Orthod. 2010; 44(2):97–103; quiz 105.

[8] Wilcko WM, Wilcko T, Bouquot JE, Ferguson DJ. Rapid orthodontics with alveolar reshaping: two case reports of decrowding. Int J Periodontics Restorative Dent. 2001; 21(1):9–19.

[9] Sebaoun JD, Ferguson DJ, Wilcko MT, Wilcko WM. Alveolar osteotomy and rapid orthodontic treatments. Orthod Fr. 2007; 78(3):217–25.

[10] Wilcko MT, Wilcko WM, Pulver JJ, Bissada NF, Bouquot JE. Accelerated osteogenic orthodontics technique: a 1-stage surgically facilitated rapid orthodontic technique with alveolar augmentation. J Oral Maxillofac Surg. 2009; 67(10):2149–59.

[11] Wolford LM, Chemello PD, Hilliard F. Occlusal plane alteration in orthognathic surgery—part I: effects on function and esthetics. Am J Orthod Dentofacial Orthop. 1994; 106(3):304–16.

[12] Frost HM. The biology of fracture healing. An overview for clinicians. Part I. Clin Orthop Relat Res.1989 ;(248):283–93.

[13] Hernández-Alfaro F, Guijarro-Martínez R. Endoscopically assisted tunnel approach for minimally invasive corticotomies: a preliminary report. J Periodontol. 2012; 83(5):574–80.

[14] Hernández-Alfaro F, Guijarro-Martínez R. ‘‘Twist technique’’ for pterygomaxillary dysjunction in minimally invasive Le Fort I osteotomy. J Oral Maxillofac Surg. 2013; 71(2):389–92.

[15] Cangemi Jr CF. Administration of general anesthesia for outpatient orthognathic surgical procedures. J Oral Maxillofac Surg. 2011; 69(3):798–807.

[16] Yao CC, Lai EH, Chang JZ, Chen I, Chen YJ. Comparison of treatment outcomes between skeletal anchorage and extraoral anchorage in adults with maxillary dentoalveolar protrusion. Am J Orthod Dentofacial Orthop. 2008; 134(5):615–24.

[17] Chung KR, Kim SH, Lee BS. Speedy surgical–orthodontic treatment with temporary anchorage devices as an alternative to orthognathic surgery. Am J Orthod Dentofacial Orthop. 2009; 135(6):787–98.

[18] Mimura H. Treatment of severe bimaxillary protrusion with miniscrew anchorage: treatment and complications. Aust Orthod J. 2008; 24(2):156–63.

[19] Upadhyay M, Yadav S, Nanda R. Vertical dimension control during en-masse retraction with mini-implant anchorage. Am J Orthod Dentofacial Orthop. 2010; 138(1):96–108.

[20] Frost HM. The regional acceleratory phenomenon: a review. Henry Ford Hosp Med J. 1983; 31(1):3–9.

[21] Skaggs JE. Surgical correction of prognathism. Am J Orthod. 1959; 45(4):265–71.

[22] Dowling PA, Espeland L, Krogstad O, Stenvik A, Kelly A. Duration of orthodontic treatment involving orthognathic surgery. Int J Adult Orthodon Orthognath Surg. 1999; 14(2):146–52.

[23] Diaz PM, Garcia RG, Gias LN, AguirreJaime A, Perez JS, de la Plata MM, Navarro EV, Gonzalez FJ. Time used for orthodontic surgical treatment of dentofacial deformities in white patients. J Oral Maxillofac Surg. 2010; 68(1):88–92.

[24] Schendel SA, Wolford LM, Epker BN. Mandibular deficiency syndrome. Oral Surg Oral Med Oral Pathol. 1978; 45(3):364-77.

[25] Wolford LM, Schendel SA, Epker BN. Surgical-orthognathic correction of mandibular deficiency in growing children. J Maxillofac Surg. 1979; 7(1):61-72.

[26] Mojdehi M, Buschang PH, English JD, Wolford LM. Postsurgical growth changes in the mandible of adolescents with vertical maxillary excess growth pattern. Am J Orthod Dentofacial Orthop. 2001; 119(1):106–16.

[27] Wolford LM, Morales-Ryan CA, García-Morales P, Perez D. Surgical management of mandibular condylar hyperplasia type 1. Bayl Univ Med Cent Proc. 2009; 22(4):321–9.

[28] Lee S, McGrath C, Samman N. Impact of orthognathic surgery on quality of life. J Oral Maxillofac Surg. 2008; 66(6):1194-9.

[29] Takeshita WM, Silva TP, de Souza LLT, Tenorio JM. State of the art and prospects for artificial intelligence in orthognathic surgery: A systematic review with meta-analysis. J Stomatol Oral Maxillofac Surg. 2024; 125(6):101787.

[30] Kawai N, Shibata M, Watanabe M, Horiuchi S, Fushima K, Tanaka E. Effects of functional training after orthognathic surgery on masticatory function in patients with mandibular prognathism. *J Dent Sci.* 2020; 15(4):419-425.

[31] Proffit WR, Phillips C, Turvey TA. Long-term stability of adolescent versus adult surgery for treatment of mandibular deficiency. Int J Oral Maxillofac Surg. 2010; 39(4):327–32.

[32] Gupta S. Effectiveness of traditional and virtual surgical planning in orthognathic surgery: a systematic review and meta-analysis. Cureus. 2025; 17(2):e79033.

[33] Güngör D, Nadaud P, LaPergola CC, Dreibelbis C, Wong YP, Terry N, et al. Infant milk-feeding practices and diabetes outcomes in offspring: a systematic review. *Am J Clin Nutr*. 2019 Mar 1; 109(Suppl_7):817S-837S.

[34] Villegas C, Oberti G, Jimenez I, Franchi L, Baccetti T. Early orthognathic surgery in growing Class III patients. J Clin Orthod. 2010; 44(11):14.

[35] Capelli Junior J, Almeida RCC. Orthosurgical treatment of patients in the growth period: At what cost? Dent Press J Orthod. 2012; 17(6):159–77.

[36] Hedge M, Hedge C, Parajuli U, Kamath P. Combined orthodontic and surgical correction of an adolescent patient with thin palatal cortex and vertical maxillary excess. Kathmandu Univ Med. 2012; 10(39):88–92.

[37] O'Keefe C, Sinnott P. Early orthognathic surgery in response to bullying due to malocclusion. J Ir Dent Assoc. 2016; 62(6):343–7.

[38] Meltzer H, Vostanis P, Ford T, Bebbington P, Dennis MS. Victims of bullying in childhood and suicide attempts in adulthood. Eur Psychiatry. 2011; 26(8):498–503.

[39] Al-Bitar ZB, Al-Omari IK, Sonbol HN, Al-Ahmad HT, Cunningham SJ. Bullying among Jordanian school children, its effects on school performance, and the contribution of general physical and dentofacial features. Am J Orthod Dentofacial Orthop. 2013; 144(6):872–8.

[40] Wolford LM, Karras SC, Mehra P. Considerations for orthognathic surgery during growth, Part 2: Maxillary deformities. Am J Orthod Dentofacial Orthop. 2001; 119(2):102–5.

[41] Yaffe A, Fine N, Binderman I. Regional accelerated phenomenon in the mandible following mucoperiosteal flap surgery. J Periodontol. 1994; 65(1):79–83.

[42] Strippoli J, Aknin JJ. Accelerated tooth movement by alveolar corticotomy or piezocision. Orthod Fr. 2012; 83(2):155–64.

[43] Luther F, Morris DO, Hart C. Orthodontic preparation for orthognathic surgery: how long does it take and why? A retrospective study. Br J Oral Maxillofac Surg. 2003; 41(6):401–6.

[44] Hong KJ, Lee JG. 2 phase treatment without preoperative orthodontics in skeletal class III malocclusion. J Korean Assoc Oral Maxillofac Surg. 1999; 25(1):48–53.

[45] Baek SH, Ahn HW, Kwon YH, Choi JY. Surgery-first approach in skeletal Class III malocclusion treated with 2-jaw surgery: evaluation of surgical movement and postoperative orthodontic treatment. J Craniofac Surg. 2010; 21(2):332–8.

[46] Kim SJ, Kim MR, Shin SW. Evaluation on the psychosocial status of orthognathic surgery patients. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009; 108(6):828–32.

[47] Mertens B, Angioni C, Orti V, Canal P. Collaboration between periodontics and orthodontics: interest of alveolar corticotomies and piezocision. Review of literature. Orthod Fr. 2017; 88(2):179–91.

[48] Sebaoun JD, Surmenian J, Dibart S. Accelerated orthodontic treatment with piezocision: a mini-invasive alternative to conventional corticotomies. Orthod Fr. 2011; 82(4):311–9.

[49] Liou EJ, Chen PH, Wang YC, Yu CC, Huang CS, Chen YR. Surgery-first accelerated orthognathic surgery: orthodontic guidelines and setup for model surgery. J Oral Maxillofac Surg. 2011; 69(3):771–80.

[50] Washburn MC, Schendel SA, Epker BN. Superior repositioning of the maxilla during growth. J Oral Maxillofac Surg. 1982; 40(3):142–9.

[51] Iino S, Sakoda S, Ito G, Nishimori T, Ikeda T, Miyawaki S. Acceleration of orthodontic tooth movement by alveolar corticotomy in the dog. Am J Orthod Dentofacial Orthop. 2007; 131(4):448.e1-8.

[52] Lee W, Karapetyan G, Moats R, Yamashita DD, Moon HB, Ferguson DJ, et al. Corticotomy-osteotomy-assisted tooth movement microCTs differ. J Dent Res. 2008; 87(9):861–7.

[53] Charavet C, Lambert F, Lecloux G, Le Gall M. Accelerated orthodontic treatment using corticotomies: what are the minimally invasive alternatives? Orthod Fr. 2019; 90(1):5–12.

[54] Yu HB, Mao LX, Wang XD. The surgery-first approach in orthognathic surgery: a retrospective study of 50 cases. Int J Oral Maxillofac Surg. 2015; 44(12):1463–7.