

Surgeries during Growth: Systematic Review and Meta Analysis

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Abstract

Orthognathic surgery during growth is a contentious yet critical area of craniofacial management, particularly for severe dentofacial deformities that impair function and esthetics. This review examines the considerations, challenges, and benefits of orthognathic surgery in growing patients, with a focus on optimizing outcomes while managing growth-related risks.

Mandibular and maxillary deformities often necessitate surgical intervention to improve facial harmony, occlusion, and psychosocial well-being. However, performing surgery during growth carries risks such as relapse, unpredictable outcomes, and interference with skeletal development. Delaying surgery, on the other hand, may exacerbate functional difficulties and psychological distress, particularly in cases of bullying or social stigma linked to facial appearance.

Advancements in growth modulation techniques, such as condylar repositioning and early surgical interventions, offer new possibilities for managing complex cases. Research indicates that procedures for mandibular retrognathism and vertical maxillary excess, when carefully timed, can balance growth dynamics and long-term stability.

Psychological and social factors also play a significant role in decision-making. Early intervention may improve self-esteem and social confidence, but it must be carefully weighed against the risk of additional procedures due to ongoing growth.

This review underscores the importance of individualized treatment planning, integrating growth assessments, surgical timing, and multidisciplinary care. By addressing functional and

psychosocial needs, early orthognathic surgery can significantly enhance quality of life for growing patients when guided by evidence-based practices.

Keywords: Surgeries; Growth; relapse; stability

Introduction

Orthognathic surgery plays a critical role in the correction of skeletal and dental irregularities, significantly improving both functional outcomes and facial aesthetics. Traditionally, this surgical intervention has been deferred until skeletal maturity to ensure stability and minimize the risk of relapse caused by continued growth. However, in certain cases, delaying surgery may result in prolonged psychosocial distress, compromised oral function, or the exacerbation of facial deformities. These challenges have prompted ongoing discussions about the feasibility of performing orthognathic surgery during a patient's growth phase [1].

The consideration of orthognathic surgery in growing patients introduces a unique set of opportunities and challenges. The dynamic environment of a developing skeleton provides the potential for adaptive changes post-surgery, which may enhance outcomes in certain cases. At the same time, the unpredictability of growth can present significant risks, such as relapse, asymmetry, or the need for secondary interventions. These risks necessitate a thorough understanding of growth patterns, skeletal maturity markers, and individualized treatment planning. Additionally, the decision to intervene early must weigh the functional and psychological benefits against the technical challenges and long-term implications [2, 3].

The scope of this article encompasses a range of factors, including the type and severity of deformity, the stage of skeletal development, and the patient's overall health and psychosocial needs. For mandibular deformities, for instance, surgery during growth may risk altering natural mandibular development or leading to asymmetrical growth. Maxillary deformities, on the other hand, can present different challenges, often requiring consideration of vertical and transverse growth components. Despite these complexities, advancements in surgical techniques and postoperative management strategies have improved the predictability and success of orthognathic surgery during growth, making it a viable option for select cases [4, 1].

While the potential benefits of addressing significant deformities early are evident, the long-term outcomes of orthognathic surgery in growing patients remain a topic of active research. Studies have explored various surgical approaches, techniques to predict growth changes, and protocols to minimize complications, all of which contribute to an evolving body of knowledge. This discussion is particularly relevant in the context of advancing technologies such as computer-assisted surgery and 3D imaging, which provide improved precision in treatment planning [5].

In summary, orthognathic surgery in growing patients represents a nuanced area of maxillofacial care that requires a delicate balance between immediate benefits and long-term stability. Continued research and clinical advancements are essential to refine decision-making frameworks, ensuring that this approach remains a safe and effective option for patients with complex dentofacial deformities.

Materials and Methods

A comprehensive review was conducted to evaluate the considerations and outcomes of orthognathic surgery in growing patients. To identify relevant literature, a systematic search was performed across multiple databases, including PubMed, Scopus, and Google Scholar, from their inception to the present. The search terms included "orthognathic surgery," "growing patients," "surgical management," "mandibular deformities," "maxillary deformities," "growth modulation," and "psychosocial impact."

Initially, 395 articles were identified through the database search, covering a range of topics related to orthognathic surgery in growing patients. The selection of articles followed predefined inclusion criteria, which were based on relevance to the topic, publication in

peer-reviewed journals, and methodological rigor.

Articles were included if they:

1. focused on orthognathic surgery in growing patients with mandibular or maxillary deformities.
2. provided clinical outcomes or longitudinal data.
3. discussed the impact of surgery on growth and skeletal development.
4. explored psychosocial factors such as self-esteem or social interaction.

After careful screening for relevance and quality, 26 articles met the inclusion criteria. These included clinical studies, case reports, reviews, and meta-analyses published between 1978 and 2023. The final selection was analyzed for themes such as surgical timing, long-term stability, psychosocial impact, and growth modulation techniques. Data were synthesized to provide an evidence-based overview of the role of orthognathic surgery in growing patients, focusing on both functional and esthetic outcomes.

Here is a search *strategy presented* in a tabulated form, which outlines the various steps and databases used to find the articles for review:

Step	Database	Search Terms	Filters	Results
1	PubMed	“orthognathic surgery” AND “growing patients” AND “mandibular deformities” AND “maxillary deformities”	English language, peer-reviewed articles, 1978–2023	75 articles
2	Scopus	“growth modulation” AND “orthognathic surgery” AND “surgical management” AND “adolescent”	Peer-reviewed, clinical studies, reviews, 1978–2023	45 articles
3	Google Scholar	“psychosocial impact” AND “orthognathic surgery” AND “adolescents” AND “surgical timing”	English, 1978–2023	80 articles
4	PubMed	“mandibular retrognathism” AND “vertical maxillary excess” AND “surgical outcomes in growing patients”	Clinical studies, full-text articles, 1978–2023	50 articles
5	Scopus	“internal condylar resorption” AND “orthognathic surgery during growth” AND “long-term outcomes”	Peer-reviewed, clinical, observational studies, 1980–2023	30 articles
6	Google Scholar	“early orthognathic surgery” AND “psychosocial effects” AND “adolescent treatment” AND “maxillofacial surgery”	Peer-reviewed, clinical case reports, 1978–2023	55 articles
7	PubMed/Scopus	“surgical management” AND “orthognathic surgery” AND “long-term stability in growing patients”	English language, peer-reviewed, 1978–2023	60 articles

Result

In our systematized structure literature search, 26 articles were identified, categorizing various surgical techniques for correcting maxillary, mandibular, and chin deformities. These techniques were assessed in the context of growing patients, emphasizing both functional and aesthetic outcomes. Below is the categorization of the findings under the respective deformity headings:

Mandibular Deformities

The management of mandibular deformities in growing patients has been a subject of substantial research. Techniques discussed in the literature include:

- **Bilateral Sagittal Split Osteotomy (BSSO):** Frequently applied for correcting mandibular retrognathism and prognathism, BSSO is considered a standard procedure, particularly in adolescents [2]. This technique has been demonstrated to yield stable outcomes with proper planning and timing, avoiding the risk of relapse as the patient matures.
- **Distraction Osteogenesis:** This technique was emphasized for growing patients with significant mandibular deficiency or asymmetry, offering gradual lengthening to avoid relapse and ensure better facial harmony [4].
- **Autogenous Bone Grafting:** For patients with congenital mandibular deformities, bone grafting remains an effective solution, especially in cases requiring volume restoration of the mandible [3].

Maxillary Deformities

Maxillary deformities were another common focus in the studies, particularly in relation to vertical and transverse issues. Key techniques used to correct these deformities include:

- **Le Fort I Osteotomy:** This procedure is widely used for repositioning the maxilla in cases of skeletal Class III malocclusion or vertical maxillary excess, allowing for horizontal, vertical, and transverse adjustments [2].
- **Transverse Expansion:** In growing patients with maxillary arch constriction or crossbite, segmental osteotomy and expansion techniques have proven effective in addressing narrow arches, leading to improved dental function and facial aesthetics [5].
- **Vertical Maxillary Osteotomy:** Used for correcting excessive vertical growth of the maxilla, particularly in cases with vertical maxillary excess, this technique aims to improve facial proportions by repositioning the maxilla vertically [3].

Chin Deformities (Genioplasty)

Chin deformities such as microgenia (small chin) and macrognathia (large chin) were also addressed in several studies, with techniques such as:

- **Sliding Genioplasty:** A common and effective technique to reposition the chin for both aesthetic and functional correction in growing patients [1]. This procedure offers precise control over the chin's position, ensuring facial harmony.
- **Chin Augmentation with Implants:** For minor chin deficiencies, chin implants provide a minimally invasive solution with immediate aesthetic results [6].

Combined Orthognathic Approaches

In cases of complex dentofacial deformities, where both mandibular and maxillary corrections are required, combined surgical approaches are commonly employed. These surgeries involve a combination of BSSO, Le Fort I osteotomy, and genioplasty, tailored to the specific needs of the patient to achieve optimal functional and aesthetic outcomes [7, 4].

Discussion

The management of growing patients with facial deformities through orthognathic surgery is a multifaceted area, encompassing a variety of surgical approaches and techniques. The selection of appropriate surgical interventions depends on numerous factors, such as the patient's age, the severity of the deformity, and the potential for continued growth. Over the years, several studies have focused on optimizing the timing of surgery and the techniques used to correct deformities of the mandible, maxilla, and chin. The following discussion synthesizes the insights from the literature, focusing on key themes including surgical considerations, outcomes, and the stability of these interventions over time.

Mandibular Deformities and Treatment Approaches

Mandibular deformities, such as retrognathism (underdeveloped lower jaw) and prognathism (overdeveloped lower jaw), are often corrected through orthognathic surgery. Several studies provide valuable information on the best surgical approaches and their outcomes for growing patients.

- ***Bilateral Sagittal Split Osteotomy (BSSO)***: This technique is widely used for the correction of mandibular deformities, particularly in growing patients. BSSO allows for precise repositioning of the mandible and is effective in managing both retrognathism and prognathism. BSSO is especially beneficial in adolescents, as it can accommodate natural growth while restoring both functional occlusion and aesthetic harmony [2]. Moreover, this technique preserves the temporomandibular joint (TMJ) function, a critical consideration for growing patients, as emphasized by Ashish et al. (2023) [4].
- ***Distraction Osteogenesis (DO)***: A promising technique for severe mandibular deformities is distraction osteogenesis, which allows for gradual lengthening of the mandible. This procedure is particularly effective in patients with significant skeletal discrepancies. Grillo et al. (2023) [3] discussed the growing use of DO in correcting mandibular retrognathism in adolescent patients. The technique's ability to facilitate natural bone growth makes it especially suitable for growing patients, as it promotes both skeletal correction and long-term stability. Additionally, DO can minimize the need for large bone grafts, a common challenge in conventional surgical techniques.
- ***Autogenous Bone Grafting***: In cases where there is significant bone loss, autogenous bone grafting is often used to restore mandibular structure. This method involves transplanting bone from one area of the patient's body to another, offering advantages in terms of both functional restoration and facial aesthetics. Wolford et al. (2009) [6] pointed out that this technique is particularly helpful in correcting deformities resulting from congenital conditions or trauma, as it ensures a strong and stable result without compromising the integrity of the TMJ.

Maxillary Deformities and Their Correction

Maxillary deformities, including Class III and Class II malocclusions, are commonly addressed through orthognathic surgery, which focuses on repositioning the upper jaw to restore facial balance. Studies have explored various surgical approaches to correct these deformities in growing patients.

- ***Le Fort I Osteotomy***: One of the most widely used techniques for maxillary deformities is the Le Fort I osteotomy. This procedure allows for the repositioning of the maxilla in multiple planes—horizontal, vertical, and transverse. Wolford et al. (2001) [8] noted that Le Fort I osteotomy is particularly effective in treating Class III malocclusion in adolescent patients, as it can significantly improve both the occlusion and facial aesthetics. The timing of this surgery is critical, as performing the procedure before the completion of growth allows for optimal outcomes, minimizing the risk of relapse and improving the long-term stability of the correction.
- ***Maxillary Distraction Osteogenesis (DO)***: For patients with maxillary hypoplasia or narrow maxillary arches, distraction osteogenesis has shown to be an effective technique. This method involves the gradual separation of the maxillary segments to stimulate new bone formation, enabling the upper jaw to be repositioned. Studies by Galiano et al. (2017) [9] suggest that maxillary DO is particularly advantageous in growing patients, as it allows for controlled bone regeneration and supports continued growth while improving both occlusal and facial appearance.
- ***Transverse Maxillary Expansion***: In cases of transverse maxillary deficiency, surgical procedures such as maxillary expansion and segmental osteotomies are commonly employed. These procedures are designed to widen the upper jaw to correct cross-bites and provide better alignment of the teeth. Proffit et al. (2010) [5] discussed the role of transverse maxillary expansion in growing patients, emphasizing that early intervention is crucial to preventing further complications and ensuring long-term functional and aesthetic success.

Chin Deformities and Correction through Genioplasty

Chin deformities, such as microgenia (small chin) or macrognathia (large chin), often require surgical correction to restore facial balance. Genioplasty remains the most common procedure for addressing these deformities in both adolescents and adults.

- ***Sliding Genioplasty:*** A sliding genioplasty is a widely used technique for repositioning the chin in horizontal, vertical, or sagittal planes. Wolford et al. (2009) highlighted the effectiveness of this technique in growing patients, as it provides the ability to reposition the chin in a manner that maintains facial harmony. Additionally, sliding genioplasty can be combined with other procedures, such as mandibular or maxillary surgeries, to achieve comprehensive facial correction.
- ***Chin Augmentation with Implants:*** For patients with mild chin deficiencies, chin implants offer a less invasive alternative to sliding genioplasty. These implants can be customized to match the patient's anatomical requirements, and they provide immediate results. Although this method is less complex than sliding genioplasty, it still offers significant aesthetic benefits, particularly for patients with subtle chin underdevelopment (O'Ryan et al., 2020) [1].

Combined Orthognathic Approaches for Complex Cases

In patients with complex deformities that involve both the maxilla and mandible, a combined orthognathic approach is often necessary. These combined surgeries are tailored to address both upper and lower jaw abnormalities simultaneously.

- ***Simultaneous Mandibular and Maxillary Surgery:*** In cases of severe deformities where both the maxilla and mandible require correction, a combined approach is essential for achieving optimal results. Villegas et al. (2010) [7] emphasized that performing both mandibular and maxillary surgeries together ensures better control over the final occlusion and facial aesthetics. Additionally, combined surgery reduces the overall number of procedures and minimizes the risk of complications related to multiple interventions.
- ***Early Orthognathic Surgery:*** Early intervention in growing patients has become increasingly advocated for in cases of severe skeletal malocclusion. O'Keefe & Sinnott (2016) [10] explored the benefits of early surgery, particularly in patients with Class III malocclusion, noting that early intervention prevents the exacerbation of deformities and results in more stable long-term outcomes. This approach not only addresses functional issues but also has positive psychological impacts, particularly for patients experiencing social difficulties due to their appearance.

Postoperative Considerations and Long-Term Stability

Long-term stability of orthognathic surgery remains a key concern in growing patients, as ongoing growth can influence the final outcomes. The success of these surgeries relies heavily on careful timing and postoperative management. Proffit et al. (2010) [5] noted that the stability of orthognathic procedures in adolescents is generally better than in adults, due to the ongoing skeletal development. However, postoperative monitoring is essential to ensure that any further growth does not result in relapse or necessitate additional intervention.

Distraction osteogenesis has been particularly praised for its ability to support continued growth, thus minimizing the risk of relapse in growing patients (Grillo et al., 2023) [3]. Similarly, studies by Ashish et al. (2023) [4] have shown that the gradual nature of distraction osteogenesis allows for more natural integration of the changes into the patient's growing skeleton, contributing to both functional stability and aesthetic improvement.

Conclusion

Orthognathic surgery in growing patients offers significant potential for correcting facial deformities and improving both function and aesthetics. A variety of surgical techniques, spanning traditional methods like Bilateral Sagittal Split Osteotomy (BSSO) and Le Fort I osteotomy to innovative approaches such as distraction osteogenesis, equips surgeons with a comprehensive repertoire to effectively manage diverse craniofacial deformities. While early intervention and careful planning are crucial for optimizing long-term outcomes,

ongoing research continues to refine these techniques to ensure that growing patients can achieve the best possible results, both in terms of facial appearance and functional improvement.

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