ORAL HEALTH AND MAXILLOFACIAL RESEARCH
Jul-Sept 2024, VOL. 1, ISSUE 3, pp. 21-25
https://doi.org/10.61577/ohmr.2024.1000016

RESEAPRO JOURNALS

OPEN ACCESS

MINI REVIEW

Pioneering orthognathics: Reshaping faces, reshaping lives

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ABSTRACT

Orthognathic surgery, integral to modern dental care, addresses both aesthetic and functional issues arising from facial deformities and jaw misalignments. Pioneering contributions by figures such as Edward Angle, Vilray Blair, Martin Wassmund, and Hugo Obwegeser have propelled the field forward, leading to contemporary techniques like Le Fort osteotomies and sagittal split osteotomies. These surgical procedures correct occlusal dysfunctions, enhance facial symmetry, and significantly improve patients' quality of life. A comprehensive preoperative assessment involving medical, dental, and sociopsychological evaluations, along with precise aesthetic analysis, is crucial for successful outcomes. Recent advancements, such as virtual surgical planning and minimally invasive techniques, have further refined orthognathic surgery, enhancing precision and reducing recovery times. The benefits of orthognathic surgery extend beyond physical corrections, encompassing psychological improvements by boosting self-esteem and social confidence. Postoperative care focuses on managing discomfort, maintaining oral hygiene, and adhering to dietary restrictions to facilitate recovery. Despite its benefits, the surgery carries potential risks, including infection, bleeding, nerve damage, and relapse, necessitating meticulous planning and patient compliance. This review highlights the historical development, current practices, and future directions of orthognathic surgery, emphasizing its transformative impact on both aesthetics and functionality in dental care.

KEYWORDS

Orthognathic surgery; Facial deformities; Virtual surgical planning; Aesthetic analysis

ARTICLE HISTORY

Received 22 July 2024;
Revised 31 July 2024;
Accepted 05 August 2024

Introduction

Orthognathic surgery, or corrective jaw surgery, is essential in modern dental care for addressing both aesthetic and functional issues related to facial deformities and jaw misalignments. This specialized surgical field corrects structural anomalies that affect occlusal function and facial symmetry, thus significantly enhancing patient's quality of life. Beyond functional improvements, orthognathic surgery also plays a crucial role in improving facial aesthetics, which boosts self-esteem and psychological well-being [1].

The field of orthognathic surgery has evolved significantly since its inception in the late 19th and early 20th centuries. Pioneers like Edward Angle and Vilray Blair made foundational contributions, with Angle, an orthodontist, collaborating with Blair to perform one of the first documented orthognathic surgeries, an ostectomy of the horizontal ramus, in 1898. This marked the beginning of a new era in maxillofacial surgery, combining dental and surgical expertise to achieve transformative outcomes [2].

Subsequent innovations by key figures such as Martin Wassmund, who introduced the anterior maxillary osteotomy, and Hugo Obwegeser, who developed the intraoral sagittal split technique, have propelled the field forward. Obwegeser's extensive research on maxillary surgery and his publication of a series on Le Fort I osteotomies in the 1960s established him as a significant contributor to modern orthognathic techniques. These milestones highlight the transformative nature of orthognathic surgery, which continues to evolve by integrating surgical precision with aesthetic refinement [2].

Orthognathic surgery's success is largely due to its interdisciplinary approach, involving collaboration among oral surgeons, orthodontists, and other dental specialists. This teamwork ensures comprehensive treatment plans addressing both functional and aesthetic aspects of facial deformities. By harmonizing facial features and optimizing bite alignment, orthognathic surgery not only enhances physical appearance but also improves speech clarity and chewing efficiency, significantly benefiting patients' daily lives [3].

The purpose of this review is to provide a comprehensive overview of the historical development, current practices, and future directions of orthognathic surgery. By examining the evolution of surgical techniques, interdisciplinary approaches, and patient outcomes, this review aims to underscore the transformative impact of orthognathic surgery on both aesthetics and functionality in modern dental care.

History

Orthognathic surgery, a cornerstone in oral and maxillofacial surgery, has evolved significantly since its inception. The development of this surgical specialty began in the late 19th century, with key pioneers laying the groundwork for contemporary techniques and practices. One of the earliest contributions was made by Edward Angle, known as the father of modern orthodontics. In collaboration with Vilray Blair, Angle performed one of the first documented orthognathic surgeries, an ostectomy of the horizontal ramus, in 1898. This procedure combined orthodontic principles with surgical intervention to correct mandibular prognathism, setting a

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precedent for future interdisciplinary approaches [4].

In the early 20th century, Martin Wassmund introduced the anterior maxillary osteotomy, addressing maxillary deformities and laying the foundation for more sophisticated corrective procedures. His techniques provided reliable methods for altering the maxillary position, significantly improving facial aesthetics and functional outcomes. Hugo Obwegeser, a seminal figure in orthognathic surgery, introduced the intraoral sagittal split technique in the 1950s, revolutionizing the field by allowing for more precise and less invasive mandibular adjustments. Obwegeser's extensive research on maxillary surgery, particularly his work on Le Fort I osteotomies, established a comprehensive framework for treating both cleft and non-cleft patients, showcasing the versatility and effectiveness of these surgical interventions [5].

Hans Luhr's work on rigid fixation methods marked another significant milestone. Luhr developed rigid and semi-rigid plating systems for stabilizing bone segments post-surgery. Initially used in traumatology, these methods were adapted for maxillofacial procedures, enhancing postoperative stability and reducing recovery times. Luhr's miniplate system has become a standard in orthognathic surgical practices. The Le Fort osteotomies, named after René Le Fort who studied facial fractures in the early 1900s, have also been integral to orthognathic surgery. The Le Fort I, II, and III osteotomies enable the repositioning of the maxilla and midface, addressing various facial deformities. These techniques have been refined over the years to increase precision and reduce complications, contributing to more predictable and aesthetically pleasing outcomes [6].

These advancements reflect the continuous evolution of orthognathic surgery, driven by interdisciplinary collaboration and innovative surgical techniques. The integration of orthodontic principles with maxillofacial surgery has resulted in procedures that not only correct functional impairments but also significantly enhance facial aesthetics. The contributions of pioneers like Angle, Blair, Wassmund, Obwegeser, and Luhr have collectively transformed orthognathic surgery into a highly effective field, offering transformative solutions for patients worldwide [7].

Clinical Assessment and Diagnosis

A comprehensive evaluation process is essential for the success of orthognathic surgery, ensuring that all aspects of a patient's condition are thoroughly understood and addressed. This multifaceted assessment includes medical analysis, dental evaluation, and sociopsychological assessment, with a particular emphasis on aesthetic evaluation to create a personalized and effective treatment plan.

Medical analysis

The initial step in the evaluation process is a detailed medical analysis. This involves gathering information about the patient's overall health, medical history, and any pre-existing conditions that could impact the surgery or recovery. Patients complete a comprehensive questionnaire during their initial visit, which provides critical data for the surgical team. Coordination with the patient's primary physician is often necessary to manage any existing health concerns and to evaluate the risks associated with general anesthesia. Particular attention is given to identifying congenital syndromes or unusual growth patterns that could affect the surgical outcome. The goal is to ensure a safe and successful surgery by minimizing potential risks through thorough preoperative planning [8].

Dental evaluation

The dental evaluation is an integral part of the assessment process and involves several key components:

History

Reviewing past treatments related to restorative work, orthodontics, periodontal care, and facial pain management helps in understanding the patient's dental background and previous interventions.

General evaluation

The state of the patient's oral hygiene and prior dental care are indicators of their dental awareness and motivation for future treatment. Conditions such as caries, periodontal disease, periapical pathology, and impacted third molars are carefully evaluated. Additionally, the need for dental implants is assessed if necessary.

Occlusal-oral function evaluation

This evaluation considers the patient's mastication, swallowing, mouth breathing, eating patterns, and maximum mouth opening. It also assesses how the deformity affects speech and habits such as tongue thrusting, thumb sucking, and lip biting.

Sociopsychological evaluation

Understanding the patient's psychological state and expectations is crucial. Miscommunication about realistic treatment outcomes and overoptimistic patient expectations can lead to dissatisfaction. Proper counseling and setting realistic expectations are essential, ensuring the patient is psychologically prepared for the treatment and its outcomes [9].

Aesthetic evaluation

The aesthetic evaluation is perhaps the most critical diagnostic procedure in orthognathic surgery, as it directly impacts the patient's appearance and self-esteem. This evaluation is performed systematically, considering both frontal and profile analyses to assess facial symmetry and proportions.

Frontal analysis

This involves evaluating facial shape, transverse dimensions, facial symmetry, and the vertical alignment of the upper, middle, and lower thirds of the face, including the lips. The relationship between facial width and vertical height is crucial for facial harmony.

Transverse dimensions

Measured using the "rule of fifths," the face is divided into five equal parts, each approximately the width of the eye. This method assesses the facial proportions and identifies any asymmetries [10].

Vertical relationships

The face is divided into three equal vertical sections: the upper third (hairline to glabella), the middle third (glabella to subnasale), and the lower third (subnasale to menton). Each section is analyzed for proportionality and alignment. For instance, the upper third's supraorbital rims should project 5-10 mm beyond the most anterior projection of the eye globe.

https://doi.org/10.61577/ohmr.2024.1000016

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The middle third's evaluation includes the nose's shape and projection, orbital rim positioning, and cheek contour. The lower third involves assessing the chin-throat area and labiomental fold [11].

Facial symmetry and lip evaluation

Facial symmetry is assessed by drawing an imaginary line through key soft tissue landmarks like the glabella, pronasale, upper lip center, lower lip, and soft tissue pogonion. The alignment of maxillary and mandibular dental midlines relative to the facial midline is crucial for planning surgical corrections. Lip evaluation focuses on symmetry and proportion, considering factors such as cleft lip, nerve dysfunction, and dentoskeletal imbalances.

The comprehensive evaluation process for orthognathic surgery ensures that all functional and aesthetic aspects are meticulously considered. This holistic approach allows for the development of a personalized treatment plan that addresses the unique needs and conditions of each patient, leading to successful surgical outcomes and improved quality of life [12].

Surgical Procedures

Orthognathic surgery encompasses various surgical procedures aimed at correcting jaw misalignments and facial deformities, with the goal of improving both functional and aesthetic outcomes. Key techniques include Le Fort osteotomies and mandibular osteotomies, each with specific procedural steps and purposes.

Le Fort osteotomies

Le Fort osteotomies are categorized into three types—Le Fort I, II, and III—based on the anatomical level of the maxillary separation.

Le Fort I osteotomy

- **Purpose:** This procedure addresses issues related to the lower maxilla, including open bite, crossbite, and maxillary hypoplasia.
- **Procedure:** A horizontal osteotomy is performed above the dentition, extending from the nasal cavity through the zygomatic buttress to the pterygoid plates. This allows for the mobilization of the lower maxilla, which can then be repositioned as required. Rigid fixation using plates and screws is employed to stabilize the maxilla in its new position [13].

Le Fort II osteotomy

- **Purpose:** Designed to correct midface deficiencies such as maxillary retrusion and midface hypoplasia.
- **Procedure:** The surgical cut is made through the nasal bridge, orbit, and extends to the maxillary sinus, creating a pyramidal separation. The maxilla and nasal complex are then repositioned and stabilized with plates and screws, enabling advancement or realignment of the midface to improve facial symmetry [14].

Le Fort III osteotomy

- **Purpose:** This procedure is utilized to correct severe midface deformities, commonly associated with craniofacial dysplasia.
- **Procedure:** The osteotomy involves a horizontal incision through the zygomatic arch, orbital rims, and nasal bridge, allowing for the mobilization of the entire midface. The maxilla, nasal bones, and zygomatic bones can then be repositioned as needed, with rigid fixation ensuring stability during the healing process [15].

Mandibular osteotomies

Mandibular osteotomies are primarily employed to address deformities of the lower jaw, such as prognathism and retrognathism.

Sagittal split osteotomy

- **Purpose:** This procedure corrects mandibular prognathism (overbite) and retrognathism (underbite).
- **Procedure:** A vertical osteotomy is performed from the posterior mandible to the anterior ramus, allowing the mandibular bone to be split sagittally. The two segments can be repositioned independently, either forward or backward. Rigid fixation with screws or plates is used to stabilize the segments in their new alignment [16].

Vertical subsigmoid osteotomy

- **Purpose:** This technique addresses mandibular asymmetry and vertical excess.
- **Procedure:** An incision is made vertically behind the mandibular second molar down to the inferior border of the mandible. This allows for vertical adjustments and repositioning of the mandibular segments, with rigid fixation employed to maintain the new alignment [17].

Recent advancements and innovative approaches

Orthognathic surgery has evolved significantly, incorporating advancements that enhance precision, reduce recovery time, and improve outcomes.

Virtual surgical planning (VSP)

- **Advancement:** Utilizes 3D imaging and computer-aided design (CAD) to enhance surgical precision.
- **Benefit:** Enables surgeons to visualize the planned outcome, perform precise cuts, and fabricate custom surgical guides. This leads to improved predictability and efficiency, resulting in better functional and aesthetic results [18].

Minimally invasive techniques:

- **Advancement:** Incorporates endoscopic-assisted methods to reduce the invasiveness of traditional procedures.
- **Benefit:** Results in smaller incisions, less scarring, and quicker recovery times, while maintaining the efficacy of the corrections [19].

Biological enhancements:

- **Advancement:** Utilizes growth factors and biomaterials to promote bone healing and regeneration.
- **Benefit:** Accelerates postoperative recovery by enhancing bone healing and reducing the risk of complications [20].

Benefits of Orthognathic Surgery

Orthognathic surgery offers numerous benefits, both aesthetic and functional, significantly improving patients' quality of life.

Aesthetic benefits

Orthognathic surgery enhances facial symmetry and balance by repositioning the jaws. This surgical intervention corrects disproportionate features, such as receding chins or overly prominent jaws. The result is a harmonized facial appearance, which improves aesthetic appeal and boosts self-confidence. Patients often experience improved facial balance and

https://doi.org/10.61577/ohmr.2024.1000016

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proportionality, leading to a more attractive profile. The psychological benefits of an improved appearance are substantial, contributing to better self-esteem and social interactions [21].

Functional benefits

Orthognathic surgery brings notable improvements in dental health, speech, and chewing functionality. By correcting malocclusion and jaw misalignment, orthognathic surgery facilitates better oral hygiene practices. Misaligned jaws can make it difficult to brush and floss effectively, increasing the risk of tooth decay and periodontal disease. Proper jaw alignment ensures that teeth meet correctly, reducing the risk of excessive wear and tear. This surgery also resolves issues like overcrowding, open bites, and crossbites, leading to a more stable and functional bite.

In terms of speech, orthognathic surgery addresses impairments caused by jaw misalignment, such as lisps or difficulty pronouncing certain sounds. By aligning the jaws correctly, the surgery enhances the control and coordination of oral structures involved in speech production. Consequently, many patients experience marked improvements in speech clarity and articulation. Chewing functionality is significantly improved as well. Misaligned jaws can hinder efficient chewing, affecting nutrition. Orthognathic surgery realigns the jaws, promoting better masticatory function and overall oral health [22].

Psychological benefits

Beyond physical and functional enhancements, orthognathic surgery has profound psychological benefits. Correcting dental and facial issues through surgery often results in a significant increase in self-confidence and self-esteem. Conditions like facial asymmetry, severe malocclusion, and jaw misalignment can contribute to feelings of self-consciousness and social anxiety. By improving facial aesthetics and symmetry, orthognathic surgery helps individuals feel more comfortable and confident in their appearance.

Many patients express a sense of relief and empowerment following surgery, no longer burdened by functional and aesthetic concerns that previously affected them. This newfound confidence can positively influence various aspects of life, including relationships, career opportunities, and overall quality of life [23].

Postoperative Care and Recovery

Recovery and postoperative care following orthognathic surgery are critical phases that require careful attention and adherence to specific guidelines to ensure optimal outcomes.

Postoperative care

Postoperative care involves managing temporary discomforts such as edema, ecchymosis, and pain. Patients are typically advised to use cold compresses to reduce swelling and take prescribed analgesics to manage discomfort. Maintaining good oral hygiene is essential to prevent infections and promote healing. Patients should follow a soft-food diet to facilitate proper healing of the jaws and avoid any strenuous activities that could impact recovery [24].

Challenges during recovery

Common challenges during recovery include edema, ecchymosis, and difficulty eating and speaking. Swelling is a natural response to surgery and can last for several weeks, gradually decreasing over time. Bruising around the surgical site is also common and typically resolves within a few weeks. Patients may experience difficulty eating and speaking due to the repositioning of the jaws and the healing process. It is important to follow the surgeon's instructions and attend all follow-up appointments to monitor healing progress and address any concerns [25].

Guidelines for maintaining oral hygiene and dietary restrictions

Maintaining oral hygiene is crucial during the recovery period. Patients should gently brush their teeth using a soft-bristled toothbrush and rinse their mouths with an antiseptic mouthwash to prevent infections. Avoiding hard or crunchy foods is important to prevent any damage to the surgical site. A soft-food diet consisting of foods like soups, smoothies, and mashed potatoes is recommended. Staying hydrated and avoiding foods that require excessive chewing will help in the recovery process [26].

Risks and Complications

Orthognathic surgery, while transformative and beneficial, carries potential risks and complications that must be thoroughly understood to ensure the best outcomes.

Infection

Postoperative infections can occur at the surgical site, leading to increased pain, swelling, and delayed healing. Proper sterile techniques, prophylactic antibiotics, and diligent postoperative care are crucial in minimizing this risk.

Bleeding

Intraoperative and postoperative bleeding is a significant risk. While bleeding during surgery is typically controlled, postoperative bleeding can occur and may require additional interventions. Patients should avoid medications that increase bleeding risk, such as aspirin, in the weeks leading up to surgery [27].

Nerve damage

Nerve damage can result in temporary or permanent numbness or altered sensation, particularly affecting the inferior alveolar nerve in the lower jaw and the infraorbital nerve in the upper jaw. Careful surgical planning and technique are essential to minimize this risk.

Relapse

Post-surgical relapse, where the jaws gradually return to their original positions, can compromise surgical outcomes. Relapse can occur due to improper healing, non-compliance with postoperative instructions, or inherent instability in the corrected jaw position. Long-term stabilization techniques and patient adherence to postoperative care, including the use of orthodontic appliances, are crucial in preventing relapse [28].

Other complications

Additional complications may include issues with bite alignment, temporomandibular joint (TMJ) dysfunction, or unfavorable changes in facial aesthetics. These complications highlight the need for a thorough preoperative assessment, including detailed medical and dental evaluations, to anticipate and plan for potential challenges.

Mitigation Strategies: To minimize these risks, thorough preoperative planning is paramount. This involves detailed imaging studies, computer-assisted surgical planning, and

https://doi.org/10.61577/ohmr.2024.1000016

interdisciplinary collaboration among oral surgeons, orthodontists, and other specialists. Skilled surgical techniques, including precise osteotomies and meticulous handling of soft tissues, are vital. Additionally, comprehensive patient education about postoperative care and adherence to follow-up appointments play a significant role in ensuring successful outcomes [29].

Conclusions

In conclusion, orthognathic surgery offers profound benefits that extend beyond functional correction. By addressing both functional and aesthetic issues, this surgery significantly enhances patients' quality of life, improving dental health, self-perception, and overall well-being. The transformative impact of orthognathic surgery is evident in the substantial improvements in facial symmetry, bite function, and speech clarity. These enhancements lead to increased self-confidence and social engagement, highlighting the far-reaching effects of the procedure.

The success of orthognathic surgery depends on meticulous preoperative planning, skilled execution, and diligent postoperative care. The collaborative efforts of a multidisciplinary team of healthcare professionals are crucial in navigating the complexities of each case and ensuring optimal outcomes. From thorough diagnostic evaluations to precise surgical interventions and comprehensive postoperative support, every step is vital in minimizing risks and maximizing the benefits for patients. Ultimately, orthognathic surgery exemplifies the advancements in medical science and the dedication of healthcare providers to improving patient lives. Through continued innovation and collaborative practice, the field of orthognathic surgery will continue to evolve, offering new hope and transformative results for individuals with jaw and facial deformities.

Disclosure statement

No potential conflict of interest was reported by the author.

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