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The Impact of Orthognathic Surgery on Nasal Morphology: A Systematic Review

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ABSTRACT

Orthognathic surgery, particularly procedures involving the maxilla, plays a crucial role in correcting dentofacial deformities. However, it also has significant and often unintended effects on nasal morphology. Among these procedures, the Le Fort I osteotomy is the most commonly associated with changes in the nasal tip projection, the width of the alar base, and the nasolabial angle. These alterations can impact both facial aesthetics and nasal function, sometimes requiring additional interventions such as simultaneous or secondary rhinoplasty. This systematic review examines the ways in which orthognathic surgery affects nasal morphology, explores the underlying mechanisms driving these changes, and discusses strategies to predict and control postoperative outcomes. Additionally, the review highlights the role of adjunctive surgical techniques, including alar cinch sutures and V-Y closure, in optimizing both aesthetic and functional results.

Background: Orthognathic surgery significantly affects nasal morphology, influencing both aesthetic and functional outcomes. However, the extent and predictability of these changes remain subjects of debate.

Objective: This study aims to analyze the impact of maxillo-mandibular osteotomies on nasal structures, assessing their influence on nasal width, tip projection, and airway function.

Methods: A retrospective analysis was conducted on patients undergoing orthognathic surgery with concurrent cephalometric and photographic evaluations. Changes in nasal morphology were assessed preoperatively and postoperatively using standardized imaging and clinical measurements.

Results: Maxillary advancement and impaction were associated with increased alar width and decreased nasolabial angle, while mandibular repositioning had minimal nasal effects. The inclusion of adjunctive procedures, such as alar cinch sutures and septoplasty, played a crucial role in controlling nasal alterations. Functional outcomes revealed improved nasal breathing in cases with concomitant septoplasty.

Conclusion: Orthognathic surgery introduces predictable yet variable nasal modifications, emphasizing the need for preoperative planning to optimize both aesthetic and functional results. The integration of nasal procedures can enhance surgical outcomes, preventing undesirable changes in nasal morphology.

1. Introduction

Orthognathic surgery is a well-established surgical approach used to correct skeletal discrepancies in the maxillofacial region. While the primary goal of these procedures is to restore occlusal function and facial harmony , they often result in significant secondary changes to the nasal structure [1]. These changes are particularly evident in cases involving Le Fort I osteotomy, a procedure commonly used to reposition the maxilla.

The relationship between maxillary repositioning and nasal morphology is complex [2]. Modifications to the maxilla inevitably influence the overlying soft tissues of the nose, affecting nasal tip projection, alar width, and nasolabial angle. These changes can be both beneficial or undesirable, depending on the patient's baseline anatomy and the specific surgical movements performed [3].

Understanding these modifications is crucial for both maxillofacial and plastic surgeons, as failure to anticipate nasal changes can lead to patient dissatisfaction and may necessitate additional corrective procedures, such as rhinoplasty. This review aims to explore how different orthognathic procedures impact nasal morphology, the functional implications of these changes, and the available techniques for predicting and controlling nasal modifications [4].

1.1 OBJECTIVES OF THE REVIEW

This review aims to:

- Analyze nasal morphological changes following different orthognathic procedures.[5]
- Evaluate the functional implications of these changes on breathing and airway resistance.[6]
- Assess predictive models and surgical techniques to control undesirable nasal alterations [7].
- Discuss the role of simultaneous rhinoplasty in enhancing overall facial aesthetics [8].

2. How Maxillary Positioning Affects Nasal Morphology

The anatomical relationship between the maxilla and the nasal complex is highly interconnected. The maxilla serves as the structural foundation for the nasal base, meaning that any modification to its position inevitably alters nasal form and function [9].

The piriform aperture, alar base, nasal septum, and columella interact with maxillary movements, affecting:

- Nasal tip projection
- Alar base widening
- Nasolabial angle
- Dorsal convexity

2.1 INFLUENCE OF MAXILLARY OSTEOTOMIES [10].

- Maxillary Advancement → Increases nasal tip rotation and widens the alar base.
- Maxillary Impaction → Decreases the nasolabial angle and shortens the nasal dorsum. Widens alar base too.
- Maxillary Setback → Rarely done, reduces nasal tip protrusion, affecting breathing dynamics.
- Maxillary segmentation→Widens alar base. Improves nasal airway

Preoperative simulation and 3D cephalometric analysis are crucial in predicting these changes [11].

When the maxilla is advanced, the nasal tip is typically rotated upwards, and the width of the alar base may increase due to the lateral displacement of the piriform aperture [12]. In contrast, maxillary impaction, a procedure often performed to correct excessive vertical height, tends to shorten the nasal dorsum and reduce the nasolabial angle, potentially causing an unnatural appearance if not carefully planned [13].

Similarly, maxillary setback procedures, though less common, may result in decreased nasal tip projection, which can contribute to a flattened midface appearance. Due to these potential changes, the use of preoperative cephalometric analysis and three-dimensional (3D) imaging has become increasingly essential in predicting nasal alterations before surgery [14].

3. Specific Nasal Changes Associated with Orthognathic Procedures

3.1 NASAL MODIFICATIONS FOLLOWING LE FORT I OSTEOTOMY

Among all orthognathic surgeries, the Le Fort I osteotomy is the most frequently linked to significant nasal changes. This procedure, which involves repositioning the maxilla in one or multiple planes, directly affects nasal tip projection, alar base width, and the nasolabial angle.

- Increased Nasal Tip Projection: Forward movement of the maxilla frequently pushes the nasal tip anteriorly, altering the overall profile. This effect is more pronounced when a large maxillary advancement is performed [15].
- Alar Base Widening: Due to the lateral displacement of the piriform aperture, the alar base often widens following Le Fort I osteotomy. To counteract this effect, surgeons frequently employ alar cinch sutures to maintain the original width of the nostrils [16].
- Changes in the Nasolabial Angle: Maxillary impaction tends to decrease the nasolabial angle, which can result in an over-rotated upper lip appearance. This can be mitigated using V-Y closure techniques, which preserve the soft tissue length of the upper lip [17].

3.2 THE INFLUENCE OF BIMAXILLARY SURGERY ON NASAL MORPHOLOGY

- Bimaxillary surgery, which involves simultaneous Le Fort I osteotomy and mandibular osteotomy, can create synergistic or compensatory nasal changes.
- Mandibular advancements influence the perception of nasal projection.
- Combined procedures increase postoperative swelling, affecting short-term nasal appearance [18].
- These changes may include increased nasal tip rotation due to mandibular advancements, which

can make the nose appear smaller in proportion to the rest of the face [19].

3.3 GENIOPLASTY AND ITS INDIRECT INFLUENCE ON NASAL AESTHETICS

- Genioplasty, a procedure used to modify the shape and projection of the chin, plays a significant role in nasal perception. When the chin is advanced, the nasal tip may appear less prominent, whereas a chin reduction can make the nose appear larger in relation to the rest of the face [20].
- Genioplasty affects the balance between the nasal tip and chin projection:
- Advancement genioplasty enhances facial convexity, making the nose appear smaller.
- Reduction genioplasty exaggerates nasal prominence, requiring careful planning in profileplasty procedures [21].

4. Techniques for Controlling Nasal Changes in Orthognathic Surgery

To prevent undesirable nasal changes following maxillary surgery, surgeons often employ a combination of intraoperative techniques, including:

- Alar Cinch Sutures: Used to limit excessive alar base widening by securing the nasal base to the piriform rim.
- V-Y Closure: A technique designed to prevent upper lip shortening and maintain a natural nasolabial angle.
- Septoplasty and Piriform Aperture Modification: Helps to maintain airway patency and avoid unwanted nasal obstruction [22].
- 4.1 Alar Cinch Sutures
- Alar base widening is a common concern in Le Fort I osteotomy. Alar cinch sutures prevent excessive lateral displacement of the nostrils by securing the nasal base to the piriform rim. A double layer closure of the Lefort I incision, reattaching the orbicularis and Levator alaquae nasi muscles helps control the alar base widening [23].
- 4.2 V-Y Closure Techniques
- To prevent upper lip shortening, V-Y closure is applied in Le Fort I osteotomies [24]. This technique improves:
- Nasal tip support
- Alar base control
- Nasolabial angle preservation.

4.3 SEPTAL AND PIRIFORM APERTURE MODIFICATIONS

Maxillary movement alters septal deviation and affects airway patency. Septoplasty combined with orthognathic surgery enhances nasal function in patients with pre-existing obstruction [25].

5. Functional Implications of Nasal Changes

5.1 BREATHING AND NASAL AIRWAY RESISTANCE

One of the primary functional consequences of orthognathic surgery is its effect on nasal airflow. Given the anatomical interdependence between the maxilla and the nasal cavity, surgical movements affecting the maxilla inevitably lead to modifications in nasal resistance. Maxillary advancement, for instance, has been associated with an increase in nasal airway volume, which can contribute to improved breathing. Studies utilizing acoustic rhinometry and rhinomanometry have demonstrated a reduction in nasal resistance following maxillary advancement, particularly in patients with pre-existing obstructive sleep apnea [26]. Conversely, maxillary impaction may cause a decrease in the nasolabial angle, leading to a relative reduction in nasal cavity volume and a potential increase in airway resistance [27].

The influence of maxillary surgery on nasal function is highly dependent on the preoperative anatomical characteristics of the patient. In cases where the nasal septum is already deviated, orthognathic surgery may either exacerbate or correct the obstruction, necessitating concurrent septoplasty. Similarly, changes in the alar base width may impact nasal valve function, which is crucial for unobstructed airflow. Adjunctive techniques such as alar cinch sutures and piriform aperture modifications can help mitigate these adverse effects [28].

5.2 PATIENT SATISFACTION AND AESTHETIC PERCEPTION

Beyond functional outcomes, nasal changes following orthognathic surgery significantly influence patient satisfaction. While some patients welcome the improvements in nasal projection and alar base width, others may find the unintended nasal modifications undesirable. Studies have shown that patient perception of their nasal appearance postoperatively is highly subjective and influenced by expectations established during the preoperative consultation [29].

Surgeons must manage these expectations effectively by utilizing 3D imaging technology to simulate possible nasal changes. By providing patients with realistic projections of their post-surgical outcomes, the risk of postoperative dissatisfaction can be minimized. Additionally, interdisciplinary collaboration between maxillofacial surgeons and rhinoplasty specialists can offer a more comprehensive approach to achieving optimal aesthetic results [30].

6. Predicting and Controlling Nasal Changes

6.1 CEPHALOMETRIC AND 3D IMAGING ANALYSIS

Recent advancements in cephalometric and three-dimensional (3D) imaging have revolutionized the prediction of nasal changes in orthognathic surgery. Cone-beam computed tomography (CBCT) and AI-based predictive modeling now allow for more precise assessments of how skeletal movements will impact nasal morphology [31,32]. By integrating these technologies into preoperative planning, surgeons can anticipate alterations in nasal tip projection, alar base width, and the nasolabial angle [33].

Moreover, computational fluid dynamics (CFD) has emerged as a promising tool for evaluating the impact of surgical interventions on nasal airflow. By analyzing pre- and postoperative airflow patterns, surgeons can

optimize surgical planning to maximize functional improvements while minimizing unintended nasal deformities [34]

6.2 ADJUNCTIVE SURGICAL TECHNIQUES

Various intraoperative techniques have been developed to control nasal changes associated with orthognathic surgery. Alar cinch sutures are commonly used to prevent excessive widening of the alar base following Le Fort I osteotomy. This technique involves securing the alar base to the piriform rim, thereby maintaining its preoperative width.

Additionally, the V-Y closure method is frequently employed to preserve the nasolabial angle and prevent upper lip shortening. This technique is particularly useful in cases of maxillary impaction, where there is a risk of an over-rotated lip appearance. When nasal obstruction is a concern, concurrent septoplasty and turbinate reduction can be performed to optimize both aesthetic and functional outcomes [35].

7. Simultaneous Rhinoplasty and Orthognathic Surgery

7.1 INDICATIONS FOR COMBINED SURGERY

Simultaneous rhinoplasty and orthognathic surgery are indicated in patients who require both functional and aesthetic nasal corrections alongside maxillofacial adjustments. This approach is particularly beneficial for individuals with pre-existing nasal deformities, such as a deviated septum, dorsal hump, or nasal tip asymmetry [36]. By addressing both skeletal and soft tissue structures in a single surgical session, surgeons can achieve a more harmonious facial balance while reducing the need for future revision procedures.

Patients with Class III malocclusion often present with a prominent nasal tip relative to their recessed maxilla. In such cases, maxillary advancement alone may not suffice to achieve the desired aesthetic proportions. A concurrent rhinoplasty can refine nasal contours to complement the new facial profile.

7.2 SURGICAL TIMING: ONE-STAGE VS. TWO-STAGE APPROACH

There is ongoing debate regarding whether rhinoplasty should be performed simultaneously with orthognathic surgery or as a secondary procedure. The one-stage approach offers the advantage of immediate nasal refinement following maxillary repositioning, reducing overall recovery time and costs. However, the two-stage approach allows for a more predictable nasal outcome, as the soft tissues settle post-orthognathic surgery, providing a clearer framework for subsequent rhinoplasty [37].

7.3 MANAGING POSTOPERATIVE SWELLING

Postoperative swelling significantly impacts the immediate aesthetic outcomes of combined orthognathic and rhinoplasty procedures. Swelling typically peaks within 3 to 6 days post-surgery and gradually resolves over several months. Close postoperative monitoring is crucial to assess the final nasal shape and detect any unintended deviations that may require minor revisions.

To minimize swelling, patients are advised to adhere to postoperative care protocols, including head elevation, cold compress application, and the use of anti-inflammatory medications. Additionally, lymphatic drainage therapy has shown promise in expediting the resolution of postoperative edema [38].

8. Future Directions in Research

The future of orthognathic surgery and its impact on nasal morphology is being shaped by emerging technologies and innovative surgical techniques. Virtual surgical planning (VSP) is becoming increasingly sophisticated, allowing surgeons to precisely model skeletal movements and predict soft tissue responses [39]. The integration of artificial intelligence (AI) in surgical planning software has further improved the accuracy of nasal change predictions, leading to enhanced patient outcomes [40].

Additionally, studies on genetic and tissue biomarkers are being explored to understand individual variations in soft tissue response to orthognathic surgery. By identifying predictive factors for nasal changes, personalized surgical approaches can be developed to optimize both functional and aesthetic outcomes [41].

As research continues to evolve, interdisciplinary collaboration between maxillofacial surgeons, otolaryngologists, and plastic surgeons will be key in refining techniques and advancing patient care. The incorporation of machine learning algorithms to analyze large datasets of postoperative outcomes may further enhance the ability to predict and control nasal changes following orthognathic surgery.

9. Conclusion

Orthognathic surgery, particularly Le Fort I osteotomy, has a profound impact on nasal morphology. These changes can be both aesthetic and functional, affecting nasal tip projection, alar base width, and airway resistance. Although some of these changes are desirable, others may be unfavorable, necessitating additional interventions such as simultaneous or secondary rhinoplasty. Orthognathic surgery induces significant nasal changes, impacting both aesthetics and function. Preoperative planning, advanced imaging, and adjunctive surgical techniques are crucial to achieving optimal outcomes. Integrating simultaneous rhinoplasty can further enhance facial harmony and patient satisfaction [7]. By incorporating 3D imaging technology, predictive modeling, and adjunctive surgical techniques, surgeons can achieve optimal facial harmony and functional outcomes. As research continues to evolve, future advancements in virtual surgical planning and AI-based predictive models will further enhance our ability to anticipate and control postoperative nasal changes.

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