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A Comprehensive Review of Class III Malocclusion: Etiology, Diagnosis, And Contemporary Treatment Modalities, Surgical Techniques

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A B S T R A C T

Class III malocclusion is a prevalent dental condition characterized by the anterior positioning of the lower jaw relative to the upper jaw and, at times, the cranial base. This malocclusion can disrupt normal development, impacting facial aesthetics, speech, and chewing ability in affected individuals. The etiology of Class III malocclusion is complex, involving both genetic and environmental factors. Timely diagnosis and intervention are crucial, particularly in growing children, to effectively manage this condition. This review comprehensively examines the etiology, diagnosis, and contemporary treatment modalities for Class III malocclusion. It delves into various diagnostic tools and challenges associated with diagnosing Class III malocclusion in growing children. Furthermore, the review offers an in-depth analysis of available treatment approaches, encompassing orthodontic treatment, orthognathic surgery, and a combination of both. Each treatment modality's advantages and limitations are highlighted, and evidence-based recommendations for managing Class III malocclusion are provided. In essence, this review article seeks to furnish dental practitioners with a thorough understanding of Class III malocclusion, empowering them with the requisite knowledge and skills for effective management.

Keywords: Class III malocclusion, etiology, diagnosis, treatment modalities, orthodontic treatment, orthognathic surgery

1. INTRODUCTION

Class III malocclusion is characterized by the lower jaw positioned anteriorly in relation to the upper jaw and, at times, the cranial base, resulting in a deviation from normal development. The condition's complexity arises from a combination of genetic and environmental factors, leading to a moderate distortion in dental alignment. Its prevalence varies among races, ethnicities, and geographical regions, presenting complications ranging from dental issues to significant maxillomandibular discrepancies. Diagnosing Class III malocclusion, particularly in growing children, poses challenges, and there is an ongoing discussion about the necessity for early intervention. The effectiveness of treatment approaches often hinges on an individual's unique growth patterns, introducing complexity to its management.[1]

2. BACKGROUND

Malocclusion classification hinges on the alignment between the upper and lower dental arches. Described as prognathism or an underbite, Class III malocclusion is marked by the lower teeth protruding beyond the upper teeth, a consequence of an abnormal front-to-back alignment between the maxilla and mandible.[2]

Skeletal Class III encompasses mandibular prognathism, maxillary retrognathism, and their combinations. Dental Class III, following Angle's classification, arises when the mesiobuccal cusp of the maxillary first molar occludes with the interdental space between the first and second mandibular molars.[3] Class III subdivision occurs when there's a Class III molar relation on one side and a Class I molar relation on the other. Pseudo Class III, also known as postural Class III, results from occlusal prematurity, leading to the mandible pseudo-sliding into a Class III position.The origin of Class III malocclusion is complex, shaped by a combination of genetic, environmental, and developmental factors.[4] It often emerges from a combination of genetic predisposition, atypical maxilla and mandible growth, and external factors like oral habits or trauma. The prevalence of Class III malocclusion varies among populations, with specific ethnic groups demonstrating higher incidences.Class III malocclusion's consequences significantly impact oral health and overall quality of life.[5] Aesthetic concerns linked to Class III malocclusion can detrimentally influence self-esteem and social interactions. Managing Class III malocclusion effectively requires a comprehensive approach, integrating orthodontic and surgical interventions to address underlying skeletal and dental irregularities.

3. ORTHOGNATHIC SURGERY: AN OVERVIEW

Orthognathic surgery represents a distinctive aspect of facial surgery, offering a transformative opportunity for enhancing both a patient's facial aesthetics and occlusal function. The key to achieving successful outcomes in contemporary orthognathic surgery lies in the seamless collaboration between the surgeon and the orthodontist throughout every phase of treatment, spanning from preoperative planning to the refinement of occlusion. The integration of virtual computer planning facilitates a more precise assessment of dentofacial deformities and enhances preoperative strategizing. Moreover, it serves as an invaluable tool for comprehensive patient education, fostering a deeper understanding of the treatment process and its potential impact on self-esteem and overall well-being. [6]

4. SURGICAL TECHNIQUES

BILATERAL SAGITTAL SPLIT OSTEOTOMY

Bilateral sagittal split mandibular osteotomy (BSSO), a remarkably intricate surgical undertaking aimed at addressing an array of anatomical, dental, and functional issues associated with the mandible. Let's delve deeper into the pivotal stages of this complex procedure:

Preoperative Preparations

Meticulous administration of general anesthesia ensures that the patient remains unconscious and free from discomfort throughout the surgical procedure.

A securely positioned nasotracheal tube safeguards the patient's airway, ensuring their safety during the operation. Protection of the patient's eyes, achieved through the use of tarsorrhaphy sutures or transparent adhesive eye shields, is paramount to prevent inadvertent damage.To promote hemostasis and minimize bleeding, the surgical area is judiciously infiltrated with a local anesthetic solution containing epinephrine.[7]

Incisions and Exposure:

Precise incisions within the lower buccal vestibule of the mandibular region are crafted with care. These incisions are thoughtfully designed to

offer the optimal exposure of the surgical site while leaving a mucosal cuff to facilitate effective closure. [8]

Osteotomy:

The osteotomy process entails the exacting division of the medial ramus of the mandible, a pivotal step that permits the subsequent realignment of the mandible. Surgical instruments known as osteotomes are employed with meticulous attention to detail to complete the sagittal split, adhering scrupulously to the specified plane along the inner cortical surface of the proximal segment. Special care is taken to identify and protect the inferior alveolar nerve, the nerve responsible for providing sensation to the lower lip and chin. Typically, this nerve remains with the distal segment. [9]

Repositioning and Fixation:

After the osteotomy, the segments of the mandible (proximal and distal) are meticulously repositioned to attain the desired alignment. The use of an occlusal splint ensures that the teeth align accurately, establishing a stable bite. Temporarily, maxillomandibular fixation (MMF) is achieved using elastics in conjunction with the occlusal splint.

The fixation process, which entails securing the repositioned segments, involves the application of screws or plates. These are typically positioned internally to prevent any external scarring. [10]

Postoperative Care:

The patient's postoperative journey commences with hospitalization, a vital step to enable vigilant monitoring. This is particularly critical during the immediate postoperative phase when complications such as bleeding or airway issues may arise. A structured dietary progression is meticulously followed, beginning with clear liquids and gradually transitioning to soft foods. Rigorous oral care is paramount, encompassing the use of chlorhexidine mouth rinses and warm saltwater rinses. Prophylactic antibiotics are given preventively to guard against possible infections. Vigilant monitoring of occlusion is a pivotal aspect of postoperative care, with both the surgeon and orthodontist diligently overseeing this.

Potential Complications:

Patients are given a comprehensive understanding of potential complications, including, but not limited to, injuries to dentition, enduring sensory nerve impairment, avascular necrosis, malunion, infection, bleeding requiring transfusion, and the possibility of unforeseen corrective procedures.

Informed Consent:

The surgical team places significant emphasis on ensuring that both the patient and their family possess a complete understanding of the entire procedure, postoperative care requirements, and potential risks. This understanding is formalized through the acquisition of written consent.

LEFORTE 1 OSTEOTOMY

Over the span of several decades, surgical techniques for maxillary procedures have seen noteworthy advancements. In 1934, Axhausen (11) pioneered the use of a Le Fort I osteotomy and postoperative elastics for maxillary advancement. Building on this, Obwegeser, (12) in 1969, introduced a method involving elevated bone cuts, incorporating bone grafts to enhance both stability and aesthetics.

In the '80s, Kaminishi, (13) Bennett, and Wolford made refinements to boost stability without relying on iliac bone grafts. Following this, Wardrop and Wolford employed porous block hydroxyapatite for stabilization. Since December 1981, E.E.K. has been executing the "quadrangular Le Fort I" osteotomy, a comprehensive procedure involving mobilization, advancement, and the strategic placement of an iliac crest corticocancellous graft for stability.

This procedure is indicated for addressing maxillary-zygomatic deficiency in cases of class III skeletal malocclusion. The surgical approach is meticulously designed to rectify deficiencies and attain aesthetically pleasing outcomes. The preference for the quadrangular Le Fort I over the Le Fort II procedure lies in its versatility, notably excluding orbital rims. (14) The surgical process commences with the administration of nasoendotracheal anesthesia and a precise intraoral incision, located approximately 4 mm above the mucogingival junction. Subperiosteal dissection reveals the anterior maxilla, isolating the infraorbital nerve and orbital rim periosteum to facilitate the passive placement of an onlay iliac bone graft. Elevation of the floor of the nose exposes the maxillary rostrum, which is then excised using a chisel technique. Utilizing an oscillating saw, a bilateral osteotomy is meticulously performed through the piriform aperture, extending laterally below the foramen to the tuberosity-pterygoid plate region. The maxilla is down-fractured through finger pressure, leading to complete mobilization. Release of posterior palatal and tuberosity soft tissue attachments precedes the passive placement of the maxilla into a prefabricated splint with subsequent maxillomandibular fixation.

Exposing the cartilaginous septum allows for correction of any deflections. Transosseous suspension wires are strategically positioned from the medial orbital rim to the inferior piriform aperture without immediate tightening. Block corticocancellous bone grafts harvested from the iliac crest are then meticulously placed as an onlay-inlay stabilizing block, (15) extending to the superior infraorbital rim and laterally covering the zygomatic prominence. The subsequent steps involve contouring, notching for the infraorbital nerve, and securing the graft with transosseous suspension wires.

Upon achieving precise maxillary positioning, the wires are tightened, and additional stabilizing wires are introduced laterally. Cancellous chips are employed to ensure symmetry and eliminate any dead space. Resorbable sutures are delicately used to approximate midline nasal and lip musculature. Closure of the maxillary incision is executed in a watertight manner through a continuous horizontal mattress suture. Postoperative care adheres to a hypotensive anesthesia protocol, with a reduction in maxillomandibular fixation time when concurrent mandibular osteotomy procedures are performed. Although skeletal miniplate fixation poses challenges due to the high osseous cut, the interpositional graft facilitates a 1 to 3-week reduction in maxillomandibular fixation time. Light nocturnal elastics and adherence to a pureed soft diet are maintained during the initial 6 weeks of limited function

Despite challenges in skeletal miniplate fixation due to the high osseous cut, the inclusion of a stabilizing interpositional graft has resulted in a reduction in maxillomandibular fixation time in specific cases. In essence, the quadrangular Le Fort I osteotomy emerges as an effective solution for addressing maxillary deficiencies, offering not only improved stability but also enhanced aesthetic outcomes

GENIOPLASTY

Genioplasty, born in the 1930s, has transformed into a pivotal procedure for enhancing the form and function of the chin. From the early use of osteochondral grafts, innovations like Hofer's techniques in 1942 and later adjustments by Obwegeser (16) and Trauner (17) in 1957 have elevated its aesthetic outcomes, notably with intraoral displacement methods. The array of materials, from bone grafts to advanced implants like Silastic and Gore-Tex, has broadened augmentation possibilities. Although chin implants offer less invasive and speedier recovery, their limitations, especially in vertical augmentation, are acknowledged. The chin's role in facial harmony, influencing both appearance and character, underscores genioplasty's significance. Addressing aesthetic and functional concerns, it has become a routine practice in orthognathic surgery.

Classifications, such as micrognathia and macrognathia, contribute to understanding deviations across planes. Gattinger (18) and Brachvogel's (19) delineation of geniodysplasias aids assessment.

Operative planning involves meticulous assessments, including medical history and cephalometric analysis. The surgical process, under general anesthesia, integrates techniques like lingual tumescent anesthesia to minimize scarring. Osteotomies, executed with tools like an oscillating saw or Piezosurgery device, enable precise adjustments. Stable fixation with miniplates and screws, along with augmentation using autogenic bone grafts or substitutes, forms the procedure's core. Complications, rare but existing, require consideration (20) The impact on soft tissues, notably the lower lip's position, is a crucial aspect of genioplasty planning.(21) Understanding the interplay between bony and soft tissue changes, anticipating complications, and evaluating patient satisfaction contribute to genioplasty's success. Its integration with rhinoplasty highlights the interconnectedness of facial features, making genioplasty an evolving tool for harmonizing facial aesthetics and addressing functional concerns. As aesthetic awareness grows, genioplasty retains its value, evolving alongside advancements in the realm of chin enhancement

5.ORTHODONTIC PREPARATION

Presurgical goals involve specific tasks like decompensating dentition, aligning arches, and coordinating maxilla and mandible positions. (22) Three core principles underscore the need to plan for opposing orthodontic and surgical relapse tendencies, position incisors relative to skeletal bases, and recognize the different directions of tooth movement for surgical versus nonsurgical treatments.In a class III case example, the text illustrates strategic orthodontic steps, including maintaining or uprighting upper incisors, proclining lower incisors, using class II elastics, and creating negative overjet. It

emphasizes the critical role of monitoring and communication to avoid pitfalls like insufficient incisor decompensation or deviations from planned incisor positions.

Highlighting the evolution of treatment simulation from acetate tracings to digital tools, the emphasis is on predicting growth, tooth movements, and soft tissue changes. The primary objective remains achieving stability in the final correction, emphasizing collaboration among orthodontists, surgeons, and effective communication. The corollary principle underscores the significance of early decision-making on surgical or nonsurgical treatment. This decision ensures a smooth alignment of orthodontic movements with the chosen treatment approach. The text offers profound insights into the delicate balance and meticulous planning necessary for successful orthodontic preparation before orthognathic surgery

6.COMPLICATIONS OF ORTHOGNATHIC SURGERY

Orthognathic surgery, when conducted by skilled surgeons in high-volume centers, is generally considered safe. Here are key considerations for potential complications:

Blood Loss:

Efforts to manage blood loss are critical, utilizing hypotensive anesthesia to minimize the need for transfusions. (23) While routine single-jaw procedures seldom require blood transfusion (24) , approximately 30% of double-jaw surgeries may necessitate it. While profuse bleeding is uncommon in mandibular osteotomy, Le Fort I maxillary osteotomy may, in rare cases, necessitate angiography with embolization for uncontrolled bleeding.. Some practitioners recommend pre-depositing blood (25) for autologous transfusion in Le Fort I maxillary osteotomy.

Infection:

Infections are surprisingly infrequent due to standard antibiotic practices, involving intraoperative, intravenous, and oral antibiotics.

Nerve Injury:

Injuries to nerves (such as infraorbital and inferior alveolar) usually manifest as neurapraxias, and the return of sensibility depends on the specific injury and individual healing patterns.

Skeletal Relapse and Postoperative Malocclusion:

Rigid internal fixation helps mitigate the risk of uncontrolled skeletal relapse. Skeletal remodeling may persist for 6 to 12 months postoperatively. Early malocclusion could arise from inaccuracies in positioning and fixation, occasionally necessitating corrective measures.

Temporomandibular Joint (TMJ) Issues:

Patients with dentofacial deformities are more prone to TMJ problems. The impact of orthodontic treatment or orthognathic surgery on TMJ symptoms is unpredictable. Progressive condylar resorption, a rare cause of long-term relapse, is more prevalent in young females with Angle Class II skeletal patterns. (26)

Unfavorable Fracture at the Sagittal Split Osteotomy Site:

The occurrence of unfavorable fractures during mandibular sagittal splitting is rare (less than 2%). This complication might result from malformed bone or technical issues, requiring reduction and internal fixation. Patients should receive preoperative information about potential extended recovery periods and the likelihood of a second operation

7. POST OPERATIVE CARE

Orthognathic surgery plays a crucial role in correcting jaw and facial deformities, demanding meticulous postoperative care to ensure positive outcomes. This care involves closely monitoring patients in the recovery ward, ensuring specific criteria such as consciousness, stable vital signs, and effective pain control are met before considering discharge. (27) The surgical and anesthesia teams meticulously document any complications, postoperative directives, and prophylactic measures. Potential airway issues are taken into consideration, and in specific scenarios, techniques like intermaxillary fixation or guiding elastics may be employed.Patients may recover in various care settings, ranging from Level 0 (ward) to Level 3 (intensive care). Although the majority fall within Level 0–1 care, early detection of physiological changes is pivotal for swift escalation if needed.The initial assessment upon ward transfer involves a comprehensive review of intraoperative details, medical history, medications, and potential complications during transit. A systematic examination covering airway, respiratory, cardiovascular, and neurological assessments aids in evaluating the patient's overall condition.(28) Daily clinical assessments include monitoring physiological parameters, fluid balance, hemoglobin levels, and evaluating occlusion stability. Ensuring adequate nutritional intake during postoperative recovery, often starting with a liquid diet, is paramount for the patient's well-being. (29) The recovery period (24–48 hours) allows vigilant observation for complications like pain, swelling, bleeding, and respiratory issues. While the use of prophylactic antibiotics remains a topic of debate, the potential for infections following intraoral approaches is acknowledged.

Addressing the nutritional challenges posed by orthognathic surgery is imperative, underlining the need for strong emphasis on nutritional support. Patients may experience weight loss during recovery, emphasizing the importance of a well-structured nutritional care pathway involving a maxillofacial

dietitian.(30),(31) Postoperative dietary progression involves a gradual transition from a liquid diet to a fork-mashed diet, soft diet, and eventual return to a normal diet. The primary goal of nutritional support is to prevent malnutrition, facilitate optimal wound healing, and mitigate complications.Maintaining oral hygiene is pivotal for orthognathic patients with fixed appliances. Effective brushing techniques, utilization of interdental brushes, and considerations regarding manual versus electric toothbrushes are highlighted. (32)

8.OUTCOME AND AND LONG TERM STABILITY OF ORTHOGNATHIC SURGERY

Skeletal Class III malocclusions present intricate dental challenges in both childhood and adulthood. This case study highlights the effectiveness of orthognathic surgery in addressing such malocclusions and facial asymmetries.Research on skeletal stability post-mandibular setback surgery indicates variable relapse rates due to changes in orofacial skeletal and soft tissue components. Compensation by tongue position and function in the oral environment is noted. While mandibular setback initially narrows the airway, adaptive changes, particularly the downward movement of the hyoid bone, maintain airway dimensions in the early postoperative period. The study emphasizes the need for long-term evaluation considering potential adaptive changes.(33) (34) Bicortical screw fixation, as applied in this case, is compared with alternative methods like sliding plates or miniplates. The study suggests that retaining bicortical screws post-healing may contribute to the lasting correction of Class III malocclusion with facial asymmetry. (33)(35) Unlike bimaxillary surgery, which generally yields more stable outcomes, standalone mandibular setback procedures may offer less stability. Prolonged mandibular growth in prognathic patients, particularly those undergoing surgery at a younger age, is cited as a contributing factor. Asymmetric movements in the mandible, despite rigid fixation, can lead to relapse. Notably, the current case involving mandibular sagittal split-ramus surgery with asymmetric movement did not exhibit a relapse tendency. Possible factors include the patient's age (25 years at the treatment's outset) and the use of rigid bicortical screw fixation (33),(36)

9..IMPACT OF ORTHOGNATHIC SURGERY ON THE PATIENT'S PHYSICAL AND PSYCHOLOGICAL WELL-BEING.

Orthognathic surgery, encompassing preoperative orthodontics and surgical procedures, fosters positive psychological outcomes like heightened self-concept marked by increased self-esteem and confidence. However, variations in self-concept levels are noted in studies, attributed to patients' post-surgery expectations and experiences.Aesthetic transformations from orthognathic surgery extend to body image, with a suggested "halo effect," implying improvements in one aspect may generalize to others. (37) While some studies support this, others underscore specific enhancements in facial and dental features .Patients undergoing orthognathic surgery anticipate improved interpersonal relationships, especially with the opposite sex, reporting positive changes like increased social activity, reduced inhibitions, and improved psychosocial dimensions. Yet, certain studies suggest a potential decline in these social benefits over time, possibly as patients adapt to their altered appearance.(38) Emotionally, patients commonly experience positive mood states post-surgery, with increased well-being and happiness. Any adverse psychological effects are usually temporary, linked to coping strategies and anticipatory concerns.(39) Hence, orthognathic surgery seems to positively impact self-concept, body image, and social interactions. Ongoing research is crucial for understanding long-term effects and fluctuations in these areas. Generally, emotional well-being improves post-surgery, and any adverse psychological effects are transient

10.ADVANCES IN CLASS 3 MANAGEMENT

COMPUTER ASSISTED SURGICAL STIMULATION

Computer-Assisted Surgical Simulation (CASS) has revolutionized the correction of dentofacial deformities in orthognathic surgery, with Virtual Surgical Planning (VSP) amplifying the efficiency of preoperative preparations. The impact of CASS extends beyond orthognathic surgery, offering advantages across various oral and maxillofacial procedures. (40) The transition from 2-D plain films to multidimensional imaging, facilitated by Cone-Beam CT (CBCT) scanners, has significantly enhanced CASS in orthognathic surgery. Improved CT scanning provides intricate insights into skeletal complexities, particularly in cases of asymmetric dentofacial deformities, utilizing 3-D visualization parameters like cant, pitch, and yaw.CASS simplifies the presurgical work-up, introducing efficiency compared to traditional model surgery. Virtual planning unveils inaccuracies in data collection during the presurgical phase, enabling corrections before entering the operating room. Additional data, such as fiducial records or gyroscope calculations for natural head position (41), may be integrated based on specific CASS protocols.(42) The merging of dental and skeletal anatomy using DICOM data superimposition enables precise occlusal topography, aiding in the establishment of occlusion and the fabrication of splints. The use of intraoral fiducials aids in orienting skeletal and dental anatomy from separate CBCT scans, providing a precise virtual representation of the existing dentofacial deformity

VIRTUAL SURGICAL PLANNING

Virtual Surgical Planning (VSP) involves a web meeting for surgical planning, coordinated by the service center and facilitated by a biomedical engineer. Virtual osteotomies are generated to mimic intraoperative procedures, addressing mandibular and maxillary surgeries. The focus is on the central incisors' position, correcting midline or cant issues first. Planning includes occlusal plane changes and quantifying yaw for skeletal and dental complex symmetry. CASS provides insights into anticipated skeletal and dental movements, aiding in preoperative planning.Intraoperative efficiency is enhanced with fabricated surgical guides and jigs based on virtual planning. Jigs reinforce accuracy in clinical movements, aiding in orienting bony segments. CAD/CAM jigs streamline grafting material contouring. Custom mandibular reconstruction plates,(43)designed in conjunction with virtual planning, address large osteotomy gaps. The Orthognathic Positioning System (OPS) transfers the virtual plan to the operating room, facilitating repositioning of osteotomized

segments. VSP's accuracy and positive clinical outcomes surpass traditional model surgery, demonstrated through postoperative studies. The approach allows an average surgeon to achieve favorable surgical results consistently

11.CONCLUSION

In summary, Class III malocclusion is a complex condition with origins involving genetics, the environment, and development. It affects more than just teeth alignment, also impacting oral health, function, and appearance. Diagnosing it, especially in growing children, is challenging, and there is ongoing debate about the need for early treatment. Orthognathic surgery, a key treatment, requires a multidisciplinary approach for successful management. Surgical techniques like bilateral sagittal split osteotomy and Le Forte I osteotomy correct skeletal and dental malalignment. Genioplasty enhances cosmetic results. Orthodontic preparation is vital, with collaboration between orthodontists and surgeons being crucial. Complications are rare but can include blood loss, infection, nerve damage, and bone movement relapse. Post-op care involves close monitoring and nutritional support. The long-term stability of orthognathic surgery varies, with advances like Computer-Assisted Surgical Simulation and Virtual Surgical Planning improving precision and outcomes. Overall, orthognathic surgery positively affects physical and psychological well-being, and continued research is essential for understanding its long-term impacts

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