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Review

Post-Traumatic Facial Asymmetry: Surgical Strategies for Correction and Rehabilitation

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Abstract

The development of the body and face is expected to occur in a symmetrical manner. However, facial asymmetry may occur due to various developmental and acquired conditions. Facial asymmetry is associated with multiple functional and aesthetic consequences. Facial trauma is a leading cause of facial asymmetry in adults and children. Post-traumatic facial asymmetry can result in sudden physical and psychological distress, especially in young patients. Treatment of post-traumatic facial asymmetry is challenging due to the involvement of various contributing factors, such as associated injuries, patient's age, and comorbidities. Surgical correction of facial asymmetry has been discussed in previous studies. However, studies focusing on surgical correction of post-traumatic facial asymmetry are still lacking. This review aims to discuss post-traumatic facial asymmetry surgical correction strategies. Surgical strategies for post-traumatic facial asymmetry can be classified into orbit correction, nose correction, malar eminence and zygomatic projection correction, malocclusion correction, and ankylosis occlusion. Timely intervention combined with tailored surgical and orthodontic strategies offers the best chance for restoring both facial harmony and quality of life in affected patients.

Keywords:

Facial asymmetry, post-traumatic facial asymmetry, Facial trauma, Surgical correction

Introduction

Facial development occurs in a symmetrical way, where both halves should be identical. It begins in the third week of intrauterine life. The midface develops from lateral and medial nasal processes, as well as the maxillary process, while the lower face develops from the mandibular process (1). Although this embryonic process is expected to be synchronized, it usually fails, leading to a mild degree of facial asymmetry. This mild asymmetry is usually so minor that it often goes unnoticed by both the individual and the observer (2). However, a high degree of asymmetry may occur, resulting in noticeable asymmetry, which significantly affects facial balance and smile esthetics (3). Variations in symmetrical appearance can be attributed to differences in environmental and evolutionary factors and embryonic development (4, 5). The mandibular region, particularly on the right side, is the area where most asymmetries are observed (6-9).

The prevalence of facial asymmetry ranges from 12% to 37% based on clinical assessment, while based on radiological assessment, the prevalence scales up to 50% (10-12). Severt and Proffit found that 74% of individuals with facial asymmetry had chin deviation causing asymmetry (10). This finding indicates that facial asymmetry is more frequent in the lower third of the face compared to the middle and upper thirds. It is critical to identify the anatomical origin of facial asymmetry in clinical evaluation, as it is vital in strategizing a treatment plan. Assessment of facial asymmetry should be comprehensive, involving soft tissue, dental, and skeletal evaluation. Skeletal asymmetry may lead to serious facial deformities due to compensatory bone remodeling, while dental anomalies always lead to minimal imbalances (5). Facial asymmetry can result from congenital, developmental, or acquired disorders. It also may arise from soft or hard tissues (4). Facial trauma is considered a leading cause of acquired facial asymmetry. Post-traumatic facial asymmetry can result in sudden physical and psychological distress, especially in young patients (4). Post-traumatic facial asymmetry may persist in cases of severe comminution, prolonged delay of initial treatment, failure of definitive treatment, insufficient primary surgical correction, failure of hardware, displaced or absent bone segments, and deficient skeletal support resulting in collapse and scar-related loss of soft tissue volume (13, 14).

Management of post-traumatic facial asymmetry always requires multidisciplinary treatment due to the associated functional impairments, such as feeding difficulties or respiratory disorders (15). The coexistence of soft tissue, bone, and dental injuries makes the process of restoration of facial function and appearance more difficult (2, 5, 16-18). Several factors can influence the treatment of facial asymmetry, including tissue availability, surrounding anatomy, and the presence of other irregularities (15). Furthermore, the age of the patient, comorbidities, and the need for long-term treatment can significantly affect treatment outcomes (15).

Challenges may include financial constraints and limited access to specialized centers equipped to perform complex, high-risk surgeries. Surgical correction is one of the preferred methods in managing facial asymmetry. However, evidence discussing different techniques for surgical correction of post-traumatic facial asymmetry is lacking. This review aims to explore current evidence focusing on surgical strategies for correction and rehabilitation of post-traumatic facial asymmetry.

Methods

A comprehensive literature search was conducted in Medline (via PubMed), Scopus, and Web of Science databases up to September 1, 2025. Medical Subject Headings (MeSH) and relevant free-text keywords were used to identify synonyms. Boolean operators (AND', OR') were applied to combine search terms in alignment with guidance from the Cochrane Handbook for Systematic Reviews of Interventions. Key search terms included: "Facial asymmetry" OR "Post-traumatic facial asymmetry" AND "Surgical correction". Summaries and duplicates of the found studies were exported and removed by EndNoteX8. Any study that discusses surgical strategies for correction of post-traumatic facial asymmetry and

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published in peer-reviewed journals was included. All languages are included. Full-text articles, case series, and abstracts with the related topics are included. Case reports, comments, animal studies and letters were excluded.

Discussion

Overview of Facial Trauma

The National Trauma Bank Data stated that facial trauma accounts for 25% of all forms of injuries annually (19). This type of trauma may hinder facial growth processes, particularly in children, which significantly affects the development of the craniofacial skeleton. These effects can lead to facial asymmetry, resulting in aesthetic, physical, and psychological discomfort (20). According to the World Health Organization (WHO), more than nine deaths per minute occur due to facial trauma (21). Maxillofacial injuries are significantly more prevalent among male adults aged between 20–29 and 40–49 years. Furthermore, maxillofacial injuries are considered a major cause of mortality in children (22, 23). The leading cause of facial trauma is road traffic accidents and interpersonal violence induced by excessive alcohol consumption (20). While accidental falls and sports injuries are the main causes of facial trauma among the elderly and children/young adults (20). Furthermore, 2.3% of child abuse cases and 27% of animal/human bite cases present with facial trauma (24, 25).

Facial trauma can lead to soft or hard tissue injuries, as well as hemorrhage, sepsis, airway obstruction, and serious neurological or orthopedic conditions (26). Soft tissue injuries include simple edema, hematoma, lacerations, abrasions, and puncture wounds. Hard tissue facial fractures can be classified into mandibular fractures, nasal fractures, midfacial fractures, zygomatic complex fractures, orbital fractures, frontal sinus fractures, naso-orbital-ethmoid fractures, and panfacial fractures (22).

Mandibular fracture is considered the most common maxillofacial fracture following simple nasal fractures. All parts of the mandible can be fractured, including the mandibular angle, condyle, body, coronoid process, and symphysis, with the mandibular condyle being the most frequent site of isolated fracture. Mandibular fractures are mainly combined with fractures to the mandibular parasymphysis and condyle or fractures to the mandibular parasymphysis and angle being the most frequent combinations. They typically present with swelling, pain, restricted mouth opening (trismus), and restricted jaw movements (27).

Nasal fractures are the most common facial fractures. They mainly occur due to a blunt trauma to the face, resulting in unilateral or bilateral nasal bone fractures. Frontal processes always accompany nasal bone fracture. Notably, any neglect in the management of septal fractures may lead to long-term deformity, resulting in facial asymmetry. Identifying the pattern of deviation and the presence of any lacerations or bony steps can be done by external assessment, including visual inspection and palpation. While intranasal examination using a nasal speculum can detect septal fracture and septal hematoma, which require prompt evacuation to prevent septal necrosis and subsequent saddle-nose deformity (27).

Midfacial fractures often result from severe blunt trauma and are always associated with panfacial fracture patterns. The French surgeon, Le Fort, classified this type of fracture into three classifications: Le Fort I, II, and III. Le Fort I fractures have the lowest fracture pattern. It is a fracture involving the tooth-bearing portion of the maxilla, extending horizontally from the pterygoid plates through the lateral walls of the maxillary sinuses to the piriform aperture of the nose. Le Fort II fractures, or pyramidal fractures, start from the pterygoid plates, run through the inferomedial orbital floor in a supero-anterior direction, and terminate at the nasal bridge. Le Fort III fractures have the highest fracture pattern. This type of fracture extends laterally through the nasofrontal suture, involving the zygomatic arches and the medial and lateral orbits (27). Complete craniofacial disjunction of the midface from the skull base occurs in this fracture.

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Zygomatic complex isolated fractures are common and can occur in any of the five articulations of the zygoma with the craniofacial skeleton. A displaced fracture in the zygomatic complex leads to facial asymmetry and flattening of the malar prominence after the resolution of acute swelling. Symptoms of this fracture may include altered sensation to the ipsilateral upper lip and maxillary dentition if the fracture extends through the infraorbital foramen. Displacement of the zygoma impinging on the mandibular coronoid process leads to trismus and restriction of lateral excursive movements (27).

Orbital fracture mainly occurs in the medial wall and orbital floor medial to the infraorbital groove (28). Mechanisms of orbital fractures after blunt trauma include two theories: hydraulic and buckling theories. According to the hydraulic theory, force applied to the globe is transmitted to the orbital walls. In contrast, the buckling theory proposes that the impact is transferred from the robust orbital rim to the weaker orbital walls, leading to their fracture (29).

Overview of Facial Asymmetry

Facial asymmetry can be classified into soft tissue, skeletal, and dental asymmetry. Soft tissue asymmetry can originate from different structures, such as skin, fat, muscle, or a combination of all three (1). It involves overgrowth disorders, such as hemifacial hyperplasia and masseter muscle hypertrophy, and undergrowth disorders, such as hemifacial atrophy (30). Dental asymmetry may occur due to delayed or failed eruption of permanent teeth. It can be detected by three-dimensional evaluation. Dental asymmetry should be considered in treatment plans, as it can sometimes resemble skeletal asymmetry. Early identification of skeletal asymmetry in treatment plans is essential for better outcomes. It typically occurs due to overgrowth or undergrowth of bony tissues. Long-standing skeletal asymmetry can lead to compensatory adaptations on the contralateral side, which depends on the primary site of the bony deformity (30).

Diagnosis of facial asymmetry requires a comprehensive multimodal approach. Tools to detect facial asymmetry include thorough clinical examination, photographic evaluation, radiography, including the temporomandibular joint (TMJ) scans, 3-dimensional computer tomography (3D CT), and stereolithographic printing (STL). Ultrasonography, electromyography, bone and TMJ scintigraphy can be used as adjuvant investigations (31-33). Establishing a reliable facial midline is critical, though reference points may deviate from the true midline (31). Asymmetry can also be evaluated by dividing the face into upper, middle, and lower thirds. Postural head tilting may mask true deformities and complicate natural head position (NHP) assessment (32).

Midline soft tissue landmarks such as the glabella, nasal tip, and pogonion must be carefully analyzed. Further, mandibular guidance techniques, occlusal plane inclination (>4°), and premature dental contacts are crucial diagnostic markers, as the latter may cause pseudo-asymmetry (33, 34). While conventional two-dimensional radiographs and photographs provide limited information, their shortcomings—including magnification errors and superimposition—are overcome by 3D CT and CBCT, as recommended by Sedentex CT guidelines and the American Academy of Oral and Maxillofacial Radiology (8, 35). Stereolithographic (STL) 3D models derived from imaging assist in preoperative planning and patient education.

Post-Traumatic Facial Asymmetry Surgical Correction

Facial asymmetry treatment is challenging due to the impact of several contributing factors. These factors include the patient’s age, the location of the asymmetry, the presence of dental occlusion and teeth malposition, the presence of any functional jaw shifts, and skeletal and soft tissue involvement (1). Surgical strategies for post-traumatic facial asymmetry can be classified into orbit correction, nose correction, malar eminence and zygomatic projection correction, malocclusion correction, and ankylosis occlusion (13). Coronal incision is the preferred incision in craniofacial surgeries. Orbital injuries caused by facial trauma include telecanthus, lateral canthus malposition, and post-traumatic enophthalmos. Transnasal canthopexy is the preferred method to treat telecanthus, with

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overcorrection as the main rule. Notably, widening of the naso-orbito-ethmoidal following a malunited fracture can reduce the success of medial canthopexy. In this case, medial orbital wall osteotomy is the preferred method, as it can reposition the medial canthal tendon-bearing bone (13).

Lateral canthal malposition is preferably treated by a lateral canthopexy, with multiple techniques available. All techniques should place the tendon posterior to and within the orbital rim. A single hook is used to identify the lateral canthal tendon, which should be released from Whitnall's tubercle (13). Afterwards, sharp dissection of the septum orbitale and soft tissues from the infraorbital rim should be performed. A slight overcorrection is recommended, with careful attention to orbital rim symmetry, while ensuring that palpebral apertures are not neglected. Notably, the correct position of the lateral orbital rim is a key determinant of proper lateral canthus placement (13).

Malunited zygomatic fracture may lead to post-traumatic enophthalmos, which can be corrected by subperiosteal dissection to release the periorbita from displaced orbital fragments, realignment of the orbital framework using osteotomies, and reconstruction of the orbital walls and framework with bone grafts (13). In case of post-traumatic enophthalmos caused by a blowout fracture, returning orbital contents from the maxillary sinus and reducing the orbital volume should be performed. Notably, autografts are more suitable for orbital reconstruction than allografts.

Facial trauma may lead to malar eminence and zygomatic projection, resulting in facial asymmetry. Cases with lesser degrees of flattening of the malar eminence can be camouflaged with different alloplastic implants or autogenous tissue. Reduction of the zygoma requires a zygomatic osteotomy and outfracture or infracture, depending on whether the lateral projection of the zygoma is deficient or excessive (13). Furthermore, fracture of the zygomaticomaxillary complex accompanied by major displacement requires the recreation of the fracture and the repositioning of the zygomaticomaxillary complex. Besides the main bony reconstruction and fixation of the zygomaticomaxillary complex, ancillary procedures, such as cheek suspension and lateral canthopexy, may be performed to improve outcomes (36).

Furthermore, facial trauma may result in facial malocclusion injuries, fostering the occurrence of facial asymmetry. Maxillary arch malposition and/or vertical discrepancies are typically corrected with LeFort I osteotomy. In cases of malunited palatal fractures, the fractures must first be retraced on dental models with a saw to restore proper arch configuration. Reposition of the maxilla followed by placement of a second splint should be performed in cases of associated misalignment of mandible fracture (13). In pediatrics, mandibular growth deficiency should be treated with a costal bone graft with a cartilage cap. This technique can augment the mandible and form a neocondyle (36).

Facial trauma resulting in condylar fracture is a leading cause of temporomandibular joint ankylosis. Temporomandibular joint ankylosis is characterized by immobility of the joint and formation of a fibrous, osseous, or fibro-osseous mass ankylosed to the base of the skull (37). It can significantly cause facial asymmetry, especially when acquired at a young age. Surgical options for ankylosis release include gap arthroplasty, Esmarch's procedure, and lateral arthroplasty (38).

Future Research Recommendations

High-quality studies comparing different surgical strategies used in the management of post-traumatic facial asymmetry should be conducted. Future studies should focus on assessing long-term outcomes of post-traumatic facial asymmetry and outcomes of its surgical correction. Additionally, it is critical to conduct studies investigating this type of injury in pediatric populations, as trauma during growth carries a higher risk of long-term deformity and relapse. Eventually, future studies should focus more on advances in digital planning and 3D printing, as they can improve the effectiveness of osteotomy design, graft adaptation, and patient-specific implants.

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Conclusion

Post-traumatic facial asymmetry remains a complex condition influenced by multiple skeletal, dental, and soft tissue factors. Early recognition, accurate diagnosis, and individualized multidisciplinary management are essential to achieving functional rehabilitation and satisfactory aesthetic outcomes. Although various surgical strategies have been described, the literature still lacks robust evidence comparing their long-term effectiveness.

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Conflict of interest

There is no conflict of interest.

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Ethical consideration

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Data availability

Data that support the findings of this study are embedded within the manuscript.

Author contribution

All authors contributed to conceptualizing, data drafting, collection and final writing of the manuscript.

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