

Improvement of Soft Tissue Reconstruction for Restoring Facial Symmetry in Post-Traumatic Cheek-Orbital Complex Injuries

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Abstract

Traumatic injuries to the soft tissues of the midface, particularly the cheek–orbital complex, often result in facial asymmetry, aesthetic imbalance, and functional limitations. This study aims to analyze post-traumatic soft tissue deformities in this region and develop an enhanced approach for restoring facial symmetry. Clinical, morphological, and instrumental assessments were employed to evaluate tissue displacement, volumetric loss, and alterations in mimic function. Based on the findings, a stepwise, individualized reconstructive strategy was proposed, emphasizing anatomical proportionality, symmetry restoration, and long-term aesthetic stability. The outcomes demonstrate that this approach can effectively address post-traumatic asymmetry, providing both functional and cosmetic improvements. The results hold significant clinical and scientific relevance for maxillofacial surgical practice in post-traumatic cases.

Keywords: Facial asymmetry, post-traumatic, cheek-orbital complex, soft tissue reconstruction, midface trauma, volumetric restoration, tissue displacement, mimic function, anatomical proportions, esthetic outcome, reconstructive strategy, surgical planning, functional improvement, cosmetic enhancement, stepwise approach.

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Introduction

The midface, particularly the cheek–orbital complex, plays a crucial role in both aesthetic appearance and functional integrity of the face. Traumatic injuries to this region are among the most challenging conditions in maxillofacial surgery due to the intricate anatomy, proximity to vital structures, and the

complex interplay between soft tissue, bone, and muscular components. Damage to the soft tissues of the cheek and orbital area can result in asymmetry, deformity, and impaired facial expression, significantly affecting a patient's psychological well-being and quality of life. Post-traumatic facial asymmetry often presents with subtle contour irregularities, displacement of soft tissue, volumetric loss, and distortion of mimetic function, which are not always adequately addressed by conventional reconstructive approaches.

Historically, treatment strategies for midface trauma have focused primarily on skeletal restoration, with less emphasis on the detailed reconstruction of soft tissues. However, recent clinical experience and research have demonstrated that optimal aesthetic and functional outcomes cannot be achieved without meticulous attention to the soft tissue envelope. Soft tissue deformities may persist even after successful bone fixation, manifesting as cheek flattening, orbital rim depression, eyelid malposition, and loss of facial symmetry. These complications not only compromise cosmetic results but can also lead to functional limitations such as impaired eye closure, malar depression, and difficulties in facial expression. Therefore, an integrated approach that combines skeletal reconstruction with soft tissue restoration is essential for achieving comprehensive rehabilitation.

Advances in imaging techniques, including three-dimensional computed tomography (3D CT) and surface scanning, have improved the ability to analyze post-traumatic deformities with high precision. These tools allow for accurate assessment of tissue displacement, volumetric deficiencies, and asymmetry, enabling the surgeon to develop individualized reconstruction plans. Furthermore, modern surgical techniques, such as local flap mobilization, free tissue transfer, and fat grafting, provide versatile options to restore soft tissue volume and contour. The choice of technique must be carefully tailored to the extent of injury, tissue quality, and patient-specific anatomical considerations.

Despite these advancements, challenges remain in standardizing soft tissue reconstruction protocols for the post-traumatic cheek–orbital complex. Each case presents unique anatomical variations, patterns of tissue loss, and functional requirements, necessitating a personalized approach. Moreover, the timing of intervention—whether early primary reconstruction or delayed secondary procedures—has a significant impact on tissue healing, scar formation, and long-term symmetry. Consequently, ongoing research and clinical innovation are required to refine surgical strategies and optimize outcomes.

This study focuses on analyzing post-traumatic soft tissue deformities of the cheek–orbital complex and developing an improved reconstructive approach aimed at restoring facial symmetry. By integrating clinical evaluation, morphological assessment, and modern imaging, the research seeks to establish a stepwise, individualized methodology that addresses both aesthetic and functional deficits. The findings aim to contribute to evidence-based practice in maxillofacial surgery, offering surgeons reliable strategies for enhancing postoperative facial symmetry, patient satisfaction, and overall quality of life.

Materials and Methods

This study was conducted on a cohort of patients presenting with post-traumatic soft tissue deformities of the cheek–orbital complex. The inclusion criteria comprised adults aged 18–60 years with documented midface trauma resulting in facial asymmetry, soft tissue volume loss, or contour irregularities. Patients with pre-existing congenital facial deformities or systemic conditions affecting wound healing were excluded. A total of 35 patients were enrolled, with injuries ranging from blunt force trauma to complex fractures involving both bone and soft tissue.

Comprehensive clinical examination was performed for all patients, including assessment of facial symmetry, soft tissue displacement, malar projection, orbital contour, and eyelid position. Functional evaluation included analysis of mimetic activity, eyelid closure, and ocular protection. Preoperative imaging utilized high-resolution three-dimensional computed tomography (3D CT) combined with surface scanning to quantify volumetric deficiencies and map soft tissue displacement precisely. Measurements were compared with the contralateral, unaffected side to determine the degree of asymmetry.

Reconstructive planning followed an individualized, stepwise approach. Soft tissue restoration techniques included local flap mobilization, advancement or rotation flaps, autologous fat grafting, and selective use of dermal fillers to correct minor contour deficiencies. Surgical procedures prioritized preservation of vascular supply, restoration of anatomical landmarks, and alignment of facial planes to achieve symmetry. Intraoperative assessment of soft tissue tension, volume distribution, and mimic function guided adjustments in flap design and graft placement.

Postoperative evaluation was conducted at 1 week, 1 month, and 6 months, documenting aesthetic outcomes, symmetry improvement, scar formation, and functional recovery. Photographic documentation and 3D surface scans were used to objectively measure volume restoration and alignment. Complications such as hematoma, flap necrosis, or graft resorption were monitored and managed according to standard clinical protocols.

This methodology allowed for precise analysis of soft tissue deficits and the implementation of tailored reconstructive strategies aimed at restoring facial symmetry. The combination of clinical, morphological, and instrumental assessments ensured that both aesthetic and functional objectives were achieved in a reproducible and scientifically valid manner.

Results

A total of 35 patients with post-traumatic deformities of the cheek–orbital complex were included in the study. Among them, 22 were male and 13 female, with ages ranging from 19 to 58 years (mean age 36.4 years). The causes of trauma varied: 18 cases were due to road traffic accidents, 10 cases were from falls, and 7 cases resulted from direct blunt force. All patients demonstrated varying degrees of soft tissue asymmetry, malar flattening, orbital rim depression, and displacement of soft tissues around the zygomatic and infraorbital regions.

Preoperative 3D CT and surface scan analysis revealed that the average soft tissue volume loss in the affected cheek region was $8.2 \pm 2.4 \text{ cm}^3$ compared to the contralateral side. Displacement of soft tissues averaged $4.5 \pm 1.2 \text{ mm}$ laterally and $3.7 \pm 1.0 \text{ mm}$ inferiorly, leading to visible contour deformities in all patients. Eyelid malposition was noted in 9 patients, and mild orbital dystopia was observed in 6 patients. Functional impairment included limited mimetic activity in 12 patients, with reduced ability to fully elevate the eyebrow or engage the zygomaticus major muscle symmetrically.

Reconstructive procedures were performed according to individualized plans based on the type and extent of soft tissue deformity. Local flap mobilization was used in 21 cases, autologous fat grafting in 18 cases, and combined approaches in 12 cases. Minor contour adjustments with dermal fillers were applied in 5 cases. Surgical duration ranged from 75 to 210 minutes depending on complexity. No intraoperative complications were reported.

Postoperative evaluation at 1 month showed significant improvement in facial symmetry. Volume restoration in the cheek region averaged $7.8 \pm 2.1 \text{ cm}^3$, with residual asymmetry less than 0.8 mm in most cases. By 6 months, soft tissue stability was achieved in all patients, with symmetrical malar prominence, normalized orbital contour, and proper eyelid position. Photographic analysis and 3D surface mapping confirmed alignment of facial planes and restoration of the pre-trauma contour.

Minor complications occurred in 4 patients, including small hematomas ($n=2$) and temporary localized edema ($n=2$), which resolved spontaneously within 2–3 weeks. No flap necrosis, infection, or significant graft resorption was observed. Patient-reported satisfaction was high, with 32 patients rating aesthetic outcomes as excellent and 3 patients as good. Functional recovery, including full mimetic movement and symmetrical expressions, was documented in all patients by 6 months postoperatively.

Discussion

The results of this study highlight the critical importance of soft tissue restoration in the management of post-traumatic deformities of the cheek–orbital complex. The observed soft tissue volume loss and

displacement, ranging from 4–5 mm laterally and 3–4 mm inferiorly, underscore the need for precise anatomical analysis prior to reconstructive intervention. Conventional bone-focused approaches alone would not have addressed these deficits, as evidenced by persistent contour irregularities noted in preliminary assessments. By integrating volumetric analysis and 3D mapping, individualized surgical strategies could be formulated to achieve both aesthetic and functional outcomes.

Local flap mobilization proved highly effective for cases with moderate tissue displacement, allowing for repositioning of existing tissues while maintaining vascular supply. The use of autologous fat grafting facilitated volumetric restoration, particularly in patients with significant soft tissue loss exceeding 8 cm³. In combined approaches, the synergy of flap mobilization and fat grafting enabled correction of both displacement and volume deficiency simultaneously, resulting in optimal symmetry. These findings align with emerging literature emphasizing the necessity of a dual approach targeting both skeletal and soft tissue reconstruction.

The postoperative volume restoration observed, averaging 7.8 cm³, demonstrates that soft tissue augmentation can effectively compensate for traumatic deficits. Furthermore, residual asymmetry below 0.8 mm indicates high precision in surgical planning and execution. This precision is critical, as even minor discrepancies in malar projection or orbital contour can result in perceptible facial asymmetry. The high patient satisfaction scores corroborate the objective measurements, confirming that functional recovery and aesthetic improvement are closely intertwined.

Functional assessments revealed that restoration of mimetic activity depended not only on tissue repositioning but also on careful preservation of muscular insertions and nerve integrity. Patients who underwent flap mobilization combined with fat grafting exhibited full recovery of zygomaticus and orbicularis oculi activity, highlighting the importance of addressing both soft tissue volume and muscular dynamics. Eyelid malposition correction further illustrates that subtle contour adjustments can substantially improve both function and appearance, emphasizing the need for meticulous intraoperative evaluation.

Minor complications, including hematomas and transient edema, were self-limiting, indicating the safety of the applied techniques. The absence of flap necrosis or significant graft resorption underscores the reliability of vascularized flap techniques and careful graft handling. These outcomes support the reproducibility of the proposed stepwise reconstructive strategy in diverse post-traumatic scenarios.

In summary, the findings confirm that post-traumatic asymmetry of the cheek–orbital complex can be effectively corrected through a combination of precise soft tissue analysis, individualized reconstructive planning, and integration of flap and grafting techniques. Restoration of facial symmetry requires careful consideration of volume, displacement, and functional dynamics. The study demonstrates that a systematic, patient-centered approach results in high aesthetic and functional outcomes, minimal complications, and sustained postoperative stability. These results provide a strong foundation for further refinement of soft tissue reconstructive strategies in post-traumatic maxillofacial surgery.

Conclusion

The study demonstrates that post-traumatic deformities of the cheek–orbital complex can be effectively addressed through precise soft tissue analysis and individualized reconstructive strategies. Clinical evaluation combined with 3D imaging and surface scanning enabled accurate assessment of volume loss, tissue displacement, and asymmetry, providing a solid foundation for surgical planning. Application of local flap mobilization, autologous fat grafting, and combined approaches facilitated restoration of facial contour, malar prominence, and orbital symmetry. Functional recovery, including mimetic activity and eyelid positioning, was consistently achieved without major complications, highlighting the reliability and safety of the applied techniques.

Quantitative outcomes confirmed substantial restoration of soft tissue volume, with residual asymmetry remaining below perceptible thresholds in the majority of cases. Patient-reported satisfaction scores

aligned with objective measurements, emphasizing the importance of integrating both aesthetic and functional goals in post-traumatic reconstruction. Minor complications were limited, transient, and manageable, indicating the feasibility of the proposed stepwise approach in routine clinical practice.

Overall, the findings underscore that successful restoration of facial symmetry requires a comprehensive, patient-centered methodology that addresses volumetric deficits, tissue displacement, and functional dynamics simultaneously. The systematic approach outlined in this study provides a reproducible framework for surgeons managing midface trauma, ensuring both aesthetic enhancement and functional stability. These results contribute to evidence-based practice in maxillofacial surgery and reinforce the significance of soft tissue-focused reconstruction in achieving optimal postoperative outcomes.

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