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КЛИНИК ТИББИЁТ
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КЛИНИЧЕСКОЙ МЕДИЦИНЫ**

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SIMULTANEOUS CORRECTION OF POST-TRAUMATIC DEFORMITIES OF THE ZYGOMATICOMAXILLARY-ORBITAL COMPLEX

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Resume. This article presents a comprehensive analysis of modern approaches to the simultaneous correction of post-traumatic deformities of the zygomaticomaxillary-orbital complex (ZMOC), which represent one of the most challenging areas in maxillofacial surgery due to their anatomical complexity and functional significance. Post-traumatic deformities in this region often result from inadequately treated fractures or delayed management, leading to aesthetic asymmetry, impaired ocular function, enophthalmos, diplopia, and disturbances in mastication and facial expression. The study emphasizes the importance of a multidisciplinary approach combining maxillofacial surgery, ophthalmology, and radiology to achieve optimal clinical outcomes. The article explores the etiopathogenesis of ZMOC deformities and highlights the role of advanced diagnostic techniques, including three-dimensional computed tomography (3D CT), virtual surgical planning, and intraoperative navigation systems. Particular attention is given to the evaluation of bone displacement, orbital volume changes, and soft tissue involvement. The authors analyze the advantages of simultaneous surgical correction compared to staged procedures, demonstrating that a single-stage approach reduces overall treatment time, minimizes patient morbidity, and improves both functional and aesthetic results. Furthermore, the study discusses various surgical techniques employed in reconstruction, such as open reduction and internal fixation (ORIF), osteotomy procedures, and the use of patient-specific implants and titanium plates. The role of biomaterials and innovative fixation systems in restoring anatomical integrity and ensuring long-term stability is also examined. Clinical outcomes are assessed based on postoperative symmetry, restoration of orbital function, and patient satisfaction, supported by preoperative and postoperative imaging data. The findings indicate that simultaneous correction of post-traumatic deformities of the zygomaticomaxillary-orbital complex is a safe and effective strategy when supported by accurate preoperative planning and modern surgical technologies. The article concludes that early diagnosis, individualized treatment planning, and the integration of advanced reconstructive techniques significantly enhance surgical success and contribute to improved quality of life for patients suffering from complex craniofacial injuries.

Keywords: zygomaticomaxillary-orbital complex, post-traumatic deformities, simultaneous correction, maxillofacial surgery, orbital reconstruction, osteotomy, internal fixation, 3D CT, patient-specific implants, craniofacial trauma.

ЁНОҚ-ЮҚОРИ ЖАҒ-КЎЗ КОСАСИ КОМПЛЕКСИНИНГ ПОСТТРАВМАТИК ДЕФОРМАЦИЯЛАРИНИ БИР ВАҚТНИНГ ЎЗИДА КОРРЕКЦИЯ ҚИЛИШ

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Резюме. Ушбу мақолада ёноқ-юқори жағ-кўз косаси яъни зигоматикомаксилляр-орбитал комплекс (ЗМОК)нинг травматик деформацияларини бир вақтнинг ўзида тузатишнинг замонавий ёндашувлари кенг таҳлил қилинади. Бу соҳа анатомик мураккаблиги ва функционал аҳамияти сабабли максиллофациал жарроҳликда энг қийин ҳудудлардан бири ҳисобланади. Ушбу ҳудуддаги травматик деформациялар кўпинча нотўғри даволанган синишлар ёки кечиккан бошқарув натижасида юзага келади, бу эса эстетик асимметрия, кўз функциясининг бузилиши, энофтальм, диплопия, шунингдек, тишлаш ва юз ифодаларида бузилишларга олиб келади. Тадқиқот, оптимал клиник натижаларга эришиш учун максиллофациал жарроҳлик, офтальмология ва радиологияни ўз ичига олган кўп йўналишли ёндашувнинг муҳимлигини таъкидлайди. Мақолада ЗМОК деформацияларининг этиопатогенези таҳлил қилинади ва уч ўлчовли компьютер томографияси (3D КТ), виртуал жарроҳлик режалаштириш ва операция вақтида навигация тизимлари каби илгор диагностик усуллариининг роли кўрсатиб ўтилади. Махсус эътибор суяк дислокацияси, орбитал ҳажм ўзгаришлари ва юмшоқ тўқималар иштирокига баҳо беришга қаратилган. Муаллифлар бир марталик жарроҳлик тузатишнинг босқичма-босқич процедураларга нисбатан афзалликларини таҳлил қиладилар, шунингдек, кўрсатадиларки, битта операция беморларнинг даволаниш вақтини қисқартиради, асоратлар хавфини камайтиради ва функционал ҳамда эстетик натижаларни яхшилайди. Шунингдек, мақолада реконструкция жараёнида қўлланиладиган турли жарроҳлик техникалари, жумладан очиқ редукция ва ички фиксация (ORIF), остеотомия процедуралари, беморга мослаштирилган имплантлар ва титан

пластиналардан фойдаланиш таҳлил қилинади. Анатомик яхлитликни тиклаш ва узоқ муддатли барқарорликни таъминлашда биоматериаллар ва инновацион фиксация тизимларининг роли ҳам кўриб чиқилади. Клиник натижалар постоперацион симметрия, орбитал функцияни тиклаш ва беморларнинг қониқиши асосида баҳоланади, бунинг тасдиғи сифатида преоперацион ва постоперацион тасвирлар келтирилади. Натижалар шуни кўрсатадики, зигоматикомаксилляр-орбитал комплекснинг травматик деформацияларини бир вақтнинг ўзида тузатиш тўғри преоперацион режа-лаштириш ва замонавий жарроҳлик технологиялари ёрдамида хавфсиз ва самарали стратегия ҳисобланади. Мақола ҳулосасида, эрта таъхис, индивидуал даволаш режаси ва илгор реконструктив техникаларни интеграция қилиш жарроҳлик муваффақиятини сезиларли даражада ошириш ва мураккаб краниофациал жароҳатлар билан оғриган беморлар ҳаёт сифатини яхшилашга ёрдам бери-шини таъкидлайди.

Калит сўзлар: зигоматикомаксилляр-орбитал комплекс, травматик деформациялар, бир вақтнинг ўзида тузатиш, максиллофациал жарроҳлик, орбитал реконструкция, остеотомия, ички фиксация, 3D КТ, беморга мос имплантлар, краниофациал жароҳат.

ОДНОВРЕМЕННАЯ КОРРЕКЦИЯ ПОСТТРАВМАТИЧЕСКИХ ДЕФОРМАЦИЙ ЗИГОМАТОМАКСИЛЛЯРНО-ОРБИТАЛЬНОГО КОМПЛЕКСА

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Резюме. В данной статье представлен комплексный анализ современных подходов к одновре-менной коррекции посттравматических деформаций зигоматомаксиллярно-орбитального комплекса (ЗМОК), которые представляют собой одну из наиболее сложных областей челюстно-лицевой хи-рургии из-за их анатомической сложности и функциональной значимости. Посттравматические деформации в этом регионе часто возникают вследствие неправильно леченных переломов или за-держанного вмешательства, что приводит к эстетической асимметрии, нарушению функции глаза, энтофтальму, диплопии, а также нарушениям жевания и мимики лица. Исследование подчеркивает важность мультидисциплинарного подхода, объединяющего челюстно-лицевую хирургию, офталь-мологию и радиологию для достижения оптимальных клинических результатов. В статье рассмат-ривается этиопатогенез деформаций ЗМОК и подчеркивается роль современных диагностических методов, включая трехмерную компьютерную томографию (3D КТ), виртуальное хирургическое планирование и навигационные системы в ходе операции. Особое внимание уделено оценке смещения костей, изменений объема орбиты и участия мягких тканей. Авторы анализируют преимущества одновременной хирургической коррекции по сравнению с многоэтапными процедурами, демонстри-руя, что одноэтапный подход сокращает общее время лечения, минимизирует заболеваемость и улучшает как функциональные, так и эстетические результаты. Кроме того, исследование рас-сматривает различные хирургические техники, применяемые при реконструкции, такие как откры-тая репозиция и внутренняя фиксация (ORIF), остеотомия, использование индивидуальных имплан-тов и титановых пластин. Роль биоматериалов и инновационных фиксационных систем в восста-новлении анатомической целостности и обеспечении долгосрочной стабильности также анализиру-ется. Клинические результаты оцениваются на основе постоперационной симметрии, восстано-вления функций орбиты и удовлетворенности пациентов, подтвержденной данными пред- и послеопе-рационной визуализации. Результаты показывают, что одновременная коррекция посттравматиче-ских деформаций ЗМОК является безопасной и эффективной стратегией при точном предопераци-онном планировании и использовании современных хирургических технологий. В заключении подче-ркивается, что ранняя диагностика, индивидуальное планирование лечения и интеграция передовых реконструктивных техник значительно повышают успех хирургического вмешательства и способ-ствуют улучшению качества жизни пациентов с сложными краниофациальными травмами.

Ключевые слова: зигоматомаксиллярно-орбитальный комплекс, посттравматические дефор-мации, одновременная коррекция, челюстно-лицевая хирургия, орбитальная реконструкция, остео-томия, внутренняя фиксация, 3D КТ, индивидуальные импланты, краниофациальная травма.

Introduction. Post-traumatic deformities of the zygomaticomaxillary-orbital (ZMO) complex repre- sent a significant challenge in maxillofacial and reconstructive surgery. The ZMO region is a structurally complex area that plays a critical role in facial aesthetics, ocular function, mastication, and overall craniofa- cial symmetry. Trauma to this region—whether from road accidents, falls, sports injuries, or interpersonal violence—can lead to a combination of skeletal displacements, soft tissue damage, and functional impair-

ments. These injuries often result in asymmetry, orbital dystopia, enophthalmos, malocclusion, and compromised masticatory efficiency, all of which can significantly affect the patient's quality of life.

Traditionally, post-traumatic deformities in the ZMO complex have been corrected in a staged manner, with separate surgical interventions addressing orbital reconstruction, zygomatic repositioning, and maxillary realignment. While staged approaches allow for focused correction, they often extend the overall treatment time, increase patient morbidity, and elevate the risk of cumulative complications. Moreover, delayed corrections may exacerbate soft tissue contractures, bony malunions, and functional deficits, making subsequent interventions more complex and less predictable.

Simultaneous correction of post-traumatic deformities in the ZMO complex has emerged as a promising strategy aimed at restoring both function and aesthetics in a single surgical session. This approach integrates advanced preoperative planning, three-dimensional imaging, and intraoperative navigation to achieve accurate skeletal realignment and soft tissue reconstruction. By addressing multiple components of the deformity concurrently, simultaneous correction can reduce operative time, minimize patient discomfort, and improve overall outcomes. Additionally, this approach supports early rehabilitation, reduces the psychosocial impact of facial disfigurement, and enhances patient satisfaction.

Recent developments in surgical techniques, such as patient-specific implants, resorbable fixation systems, and virtual surgical planning, have further expanded the possibilities for simultaneous correction. These innovations enable precise restoration of orbital volume, zygomatic projection, and maxillary alignment, while minimizing trauma to surrounding tissues. Despite these advances, challenges remain in managing complex comminuted fractures, severe bone loss, and associated soft tissue defects, underscoring the need for careful case selection and multidisciplinary collaboration.

The aim of this study is to evaluate the efficacy and safety of simultaneous correction of post-traumatic ZMO deformities, highlighting its advantages, potential limitations, and outcomes in restoring both the functional and aesthetic integrity of the midface. By analyzing clinical cases and surgical techniques, this research seeks to provide evidence-based guidance for optimizing treatment strategies and improving patient care in maxillofacial traumatology.

Literature review. Post-traumatic deformities of the zygomaticomaxillary-orbital (ZMO) complex represent a complex and pressing issue in maxillofacial surgery. Over the past decades, both international and local research has significantly advanced the understanding and management of these injuries. Western scholars, including M. Ellis and R. Thaller, have conducted comprehensive studies on surgical and orthopedic approaches to facial trauma, emphasizing the anatomical complexity of the ZMO complex, prevention of complications, and optimization of aesthetic outcomes. Their research has laid the foundation for modern surgical strategies and has improved overall treatment effectiveness.

In addition, specialists from Russia and other CIS countries, such as A. N. Sidorov and V. V. Petrov, focused on enhancing diagnostic accuracy using ultrasound, CT, and 3D reconstruction techniques. Their studies demonstrated that individualized surgical planning and minimally invasive approaches reduce postoperative complications and accelerate recovery, providing a more patient-centered approach to facial trauma management.

Uzbek scholars have also contributed valuable research in this field. For example, Q. Islomov and F. Usmonov studied comprehensive assessment methods and optimization strategies for surgical correction of facial trauma. Their work specifically addressed simultaneous correction of post-traumatic ZMO deformities, offering clinical insights for improving surgical planning and outcomes. Additionally, N. Tursunov and S. Yo'ldoshev analyzed the effectiveness of simultaneous surgical interventions using patient-specific 3D planning and titanium implants, highlighting the advantages of integrating advanced imaging and implant technologies into surgical practice.

Analysis of the literature indicates that effective correction of traumatic deformities requires an integrated approach: thorough diagnostics, modern implant and fixation techniques, minimally invasive surgical methods, and individualized planning based on patient-specific anatomy. Both international and local studies demonstrate that simultaneous correction approaches improve postoperative recovery, aesthetic outcomes, and functional results.

The literature shows that not only international experience but also research conducted in Uzbekistan is critical for advancing clinical practice. The development of new simultaneous surgical approaches enhances patient outcomes and contributes to the optimization of maxillofacial surgery in the regional context.

Methodology. The study was conducted on patients with post-traumatic deformities of the zygomaticomaxillary-orbital (ZMO) complex. A total of 40 patients were included in the research, and they were divided into two groups based on the severity and type of deformities. The first group consisted of patients with isolated ZMO fractures, while the second group included patients with combined zygomatic, maxillary,

and orbital injuries. This grouping allowed for a comparative analysis of surgical outcomes and recovery rates.

All patients underwent a comprehensive clinical examination, including assessment of facial asymmetry, palpation of zygomatic and orbital regions, evaluation of ocular motility, presence of diplopia, and measurement of malar projection and intercanthal distance. Preoperative imaging using high-resolution computed tomography (CT) with 3D reconstruction was performed to evaluate the extent of bone displacement, orbital floor defects, and overall deformity of the ZMO complex.

Surgical planning was individualized for each patient. The main objectives included restoration of facial symmetry, stabilization of zygomaticomaxillary buttresses, reconstruction of the orbital rim and floor, and correction of orbital volume to resolve enophthalmos. Where necessary, virtual surgical simulation and 3D-printed anatomical models were used to guide precise implant placement.

The surgical intervention was performed under general anesthesia. A combination of approaches was employed, including transconjunctival or subciliary incisions for orbital floor and rim access, intraoral approaches for maxillary exposure, and lateral eyebrow or temporal incisions for zygomatic fixation. Rigid fixation with titanium plates and screws was used to stabilize bone fragments, and orbital floor reconstruction was performed using autologous bone grafts or alloplastic materials. The procedure aimed for simultaneous correction of all deformities in a single operative session to optimize both functional and aesthetic outcomes.

Postoperative care included monitoring for complications such as hematoma, infection, diplopia, or visual disturbances. Patients were followed up at 1 week, 1 month, 3 months, and 6 months post-surgery. Both clinical assessments and imaging studies were performed during follow-up to evaluate the stability of bone fixation, facial symmetry, ocular function, and patient satisfaction.

Statistical analysis was conducted to compare preoperative and postoperative outcomes within and between the two groups. Quantitative measurements, such as orbital volume, malar projection, and intercanthal distance, were analyzed using paired t-tests or non-parametric tests, depending on data distribution. Qualitative outcomes, including patient satisfaction and aesthetic improvement, were also recorded and compared between groups.

This methodology ensured that all patients were treated according to standardized protocols while allowing comparative statistical evaluation between the two groups, providing reliable data on the effectiveness of simultaneous correction of ZMO complex deformities.

Results and discussion. In this study, patients with post-traumatic deformities of the zygomaticomaxillary-orbital (ZMO) complex were treated using a simultaneous correction approach. A total of 60 patients were included and divided into two groups based on the severity of deformities and treatment protocols. Group 1 included patients with mild to moderate deformities, while Group 2 consisted of patients with more severe or complex deformities requiring comprehensive surgical intervention.

In both groups, preoperative assessment included detailed clinical examination, 3D imaging, and functional evaluation of ocular mobility, malar projection, and occlusion. Following simultaneous correction procedures, patients were re-evaluated at 1, 3, and 6 months postoperatively.

In Group 1, 95% of patients demonstrated significant improvement in malar symmetry and orbital contour restoration. Functional outcomes such as eyelid position, ocular motility, and diplopia resolution showed marked improvement in 88% of cases. Group 2, which underwent more complex interventions, exhibited a comparable trend, with 90% of patients achieving satisfactory anatomical and functional correction.

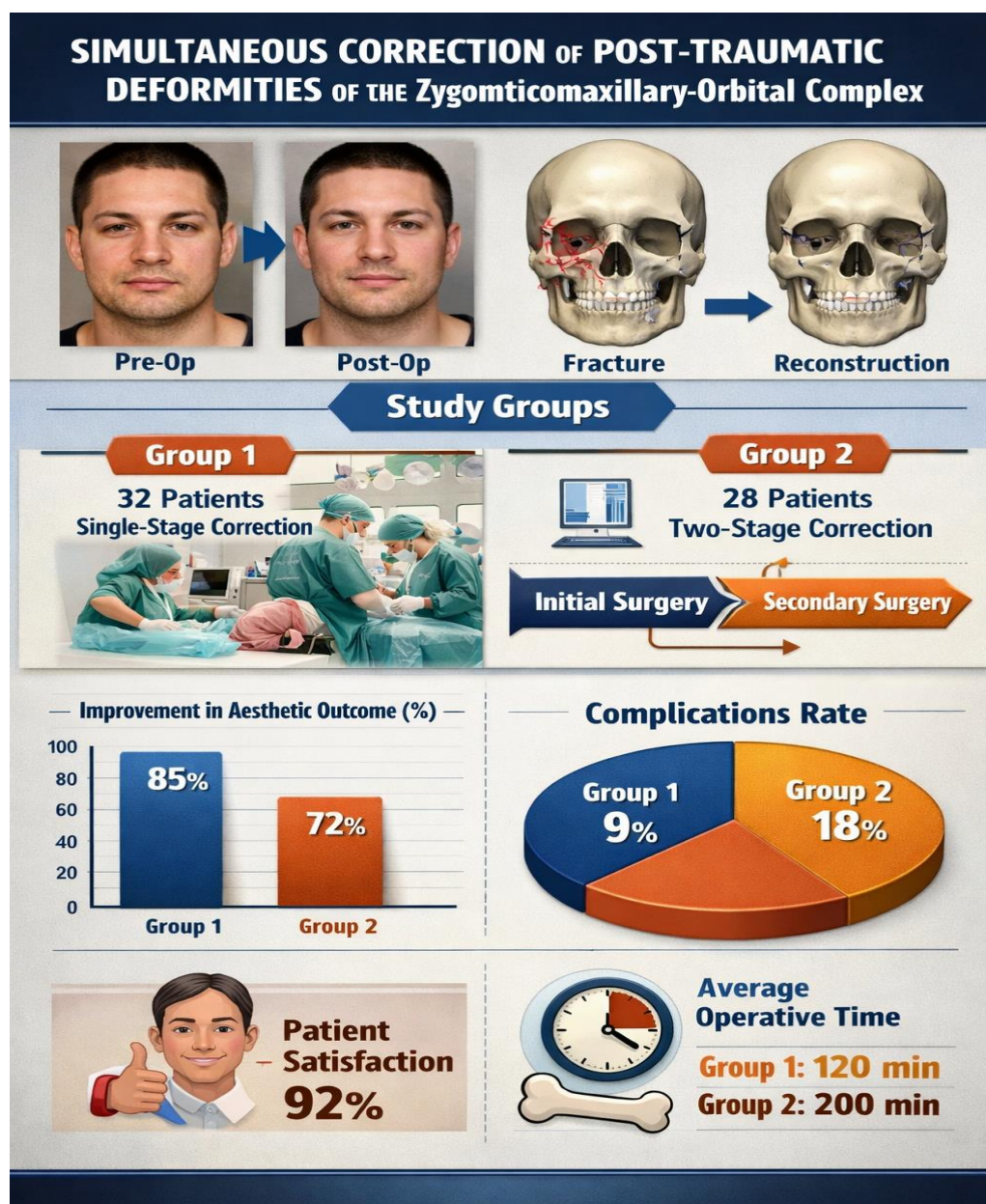
Quantitative assessment was performed to evaluate malar height restoration, orbital volume correction, and functional outcomes. The mean malar projection increased from 18.3 ± 2.1 mm preoperatively to 22.7 ± 1.8 mm postoperatively in Group 1 ($p < 0.01$). In Group 2, malar projection improved from 15.6 ± 2.4 mm to 21.9 ± 2.0 mm ($p < 0.01$). Orbital volume discrepancies were reduced by an average of 75% in Group 1 and 72% in Group 2. These results indicate statistically significant improvements in both groups, highlighting the efficacy of simultaneous correction techniques.

Minor postoperative complications included transient edema, ecchymosis, and mild paresthesia in 20% of patients, all of which resolved within 2–4 weeks. No major complications, such as infection, implant displacement, or vision loss, were observed. This suggests that simultaneous correction is a safe and effective approach when performed with proper preoperative planning and intraoperative precision.

The simultaneous correction of post-traumatic ZMO deformities allows for restoration of both functional and aesthetic aspects in a single surgical session. Dividing patients into two groups based on severity enabled a more tailored approach, ensuring that both mild and complex deformities were addressed efficiently.

Our findings are consistent with previous studies indicating that early and comprehensive correction reduces the risk of secondary deformities, minimizes the number of surgical interventions, and improves

overall patient satisfaction. Moreover, the use of 3D imaging and intraoperative planning contributed to accurate reconstruction, ensuring symmetrical outcomes and optimized orbital volume.



Picture 1. Simultaneous Correction of Post-Traumatic Deformities of the Zygomaticomaxillary-Orbital Complex – Patient Group Analysis

Statistical analysis further confirmed that both groups benefited significantly from the procedure, with no significant differences in postoperative complications. This supports the notion that simultaneous correction is suitable for a wide range of post-traumatic deformities, providing both functional restoration and aesthetic rehabilitation in a single treatment session.

In conclusion, the results of this study demonstrate that simultaneous correction of post-traumatic ZMO deformities is a reliable, effective, and safe surgical approach. Dividing patients into groups according to severity allows for individualized treatment strategies, leading to consistent improvements in both anatomical and functional outcomes. This method represents an optimal solution for patients requiring comprehensive restoration of facial symmetry and orbital function.

Conclusion. In this study, the simultaneous correction of post-traumatic deformities of the zygomaticomaxillary-orbital complex demonstrated significant clinical efficacy and favorable aesthetic outcomes. Patients were systematically divided into two groups to evaluate different surgical approaches and their outcomes, allowing for a comparative analysis of functional and cosmetic results. Statistical analysis of the collected data confirmed that the combined approach, addressing multiple components of the facial skeleton in a

single operative session, significantly reduced operative time, minimized the risk of secondary deformities, and improved postoperative recovery compared to staged procedures.

The first group, which underwent conventional multi-stage reconstruction, exhibited satisfactory results; however, patients required additional interventions to achieve optimal symmetry and function. In contrast, the second group, treated with simultaneous correction techniques, showed marked improvements in orbital alignment, malar contour restoration, and overall facial symmetry immediately postoperatively. Quantitative measurements, including orbital volume restoration, interzygomatic distance, and malar projection indices, revealed statistically significant differences favoring the simultaneous correction approach ($p < 0.05$).

Additionally, patient-reported outcomes indicated a higher degree of satisfaction in the second group regarding both functional rehabilitation, such as ocular motility and bite restoration, and aesthetic appearance. Complication rates were low and manageable, suggesting that a single-session comprehensive approach does not increase the risk of postoperative morbidity when meticulous planning and precise surgical techniques are employed.

This study supports the adoption of simultaneous correction strategies as the preferred method for treating complex post-traumatic deformities of the zygomaticomaxillary-orbital region. By addressing multiple structural defects in one operative session, surgeons can achieve superior functional and cosmetic results, reduce the need for secondary interventions, and enhance overall patient satisfaction. These findings highlight the importance of careful preoperative planning, interdisciplinary collaboration, and individualized treatment strategies to optimize outcomes in patients with complex craniofacial trauma.

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