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Osteosynthesis in the Surgical Treatment of Zygomatic Complex Fractures with Various Fixation Devices

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Keywords:
polymer osteosynthesis; resorptive bone plate; osteosynthesis for zygomatic complex fracture; zygomatico-alveolar crest

Abstract

This article presents the results of clinical and radiological examinations to determine the choice of fixation device for osteosynthesis (resorbable titanium or polymer) in the zygomatico-alveolar crest area in cases of fracture.

Aim: To choose a method for fixing bone fragments in cases of fracture of the facial bones, depending on the location of the fracture line.

Materials and methods: Patients with fractures of the zygomatic complex bones.

Results: As a result of the research, the author determined different approaches to the use of various types of fixators. Thus, in cases of comminuted fractures in the zygomatico-alveolar crest area and the presence of a bone defect, a biodegradable polymer plate, as the sole way to fix bone fragments, is impractical because in this area, it is necessary to restore the buttresses.

Conclusions. The author recommends polymer-resorbable retainers for cases involving restoring structural integrity.

Особливості остеосинтезу при хірургічному лікуванні переломів виличного комплексу з використанням різних фіксаторів

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Ключові слова:
полімерний остеосинтез; резорбтивна кісткова пластина; остеосинтез при переломі виличного комплексу; виличо-альвеолярний гребінь

Анотація

У статті відображено результати клінічного та рентгенологічного обстеження для вирішення питання вибору фіксатора для остеосинтезу (титанового або резорбтивного полімерного) у ділянці виличо-альвеолярного гребеня при переломах.

Мета: обрати метод фіксації кісткових фрагментів при переломах кісток лицевого черепа залежно від локалізації лінії перелому.

Матеріали та методи: пацієнти з переломами кісток виличного комплексу.

Результати: у результаті дослідження автор дійшов висновку про необхідність різних підходів до використання різних типів фіксаторів. Так, у випадках багатоуламкових переломів у ділянці виличо-альвеолярного гребеня та за наявності кісткового дефекту використання біодеградаційної полімерної пластини як єдиного способу фіксації кісткових фрагментів є недоцільним, оскільки в цій ділянці необхідно відновити контрфорси.

Висновки. Автори рекомендують застосовувати полімерні резорбтивні фіксатори у випадках заходів із відновлення цілісності кісток.

Introduction

Fractures of the zygomatic complex (ZCF) are the second most frequent among all fractures of the maxillofacial area ***[8, 10, 14]***. Unfortunately, the frequency of assault-related injuries has increased; furthermore, zygomatic fractures have become more complex in their nature ***[3, 8]***. Nowadays, several algorithms for providing surgical care to patients with zygomatic complex (ZC) fractures have been established ***[1, 7, 13, 15]***. To fix the bone fragments, different types of bone plates and screws are used, including titanium and resorbable options. The latter perform their function without causing harmful effects to the body. In contrast, titanium implants remain in the tissues after bone fragments consolidate. Recently, many researchers have emphasized the need to remove metal fixators after fracture consolidation due to inflammatory processes in the surrounding tissues, sensitivity to cold (cold intolerance), the patient's desire to remove the metal structure after bone fusion, etc. ***[2]***. However, there are several clinical situations in which removing the metal structure is undesirable because it serves a supporting and reconstructive function. In our previous studies, we demonstrated the feasibility of the bioactive, resorbable plates EPU-GAP-LEV for fixing midface (MF) bone fragments ***[4–6, 9, 11, 12]***. Therefore, in this and subsequent studies, we focus on the specific choice of fixators for osteosynthesis, depending on fracture location and clinical situation. Thus, in the area of the zygomatico-alveolar crest (ZAC), which is one of the midface buttresses, the choice of fixation device depends on the nature and type of the fracture.

The aim of our work is to determine the criteria for choosing the fixation device for osteosynthesis (titanium or resorbable) in the ZAC area for various types of ZCF.

Materials and methods

The study group consisted of 120 patients with fractures of the zygomatic complex (ZC). Following clinical and radiographic examinations, surgical treatment of the fractures was performed using various types of fixators. The surgery included repositioning and fixation of ZC fragments, as well as revision of the maxillary sinus using intraoral and extraoral approaches. Osteosynthesis of the ZC was performed using titanium and polymer plates based on polyurethane (EPU-GAP-LEV). Surgical planning and fixator selection were based on computed tomography (CT) data and the intraoperative presentation of the fractures. Analysis of treatment outcomes was performed using CT scans obtained 6 months after surgery, focusing on bone density in the area of ZC fragment fusion.

Research Results

The primary role in achieving stable ZC fixation in the correct position was attributed to the zygomatico-frontal suture osteosynthetic area. However, the need to fix two to three zones is an undeniable thesis. Significant support for stabilizing the ZC in space is provided by osteosynthesis in the ZAC area. Polymer osteosynthesis using bone plates and screws was performed on 79 patients. This procedure was possible in the absence of bone defects. In the vast majority of observations, the fracture gap was clearly defined, while the X-ray density profiles remained uniform due to a significant decrease in the mineral saturation of the surrounding bone. In general, radiographic bone density in the fusion area was 20–30% lower than on the intact side. The resorbable retainers for osteosynthesis, EPU-GAP-LEV, which we proposed ***[3]***, have certain advantages. Due to the inclusion of hydroxyapatite and levamisole, they exhibit excellent biocompatibility and exert a positive influence on the course of reparative regeneration of bone tissue in the fracture area. In terms of their physical and mechanical properties, they are close to natural bone ***[6]***. Therefore, during the fusion of bone fragments after osteosynthesis using these plates, the load on the bone is shared equally; there is no “stress shielding” effect, and consolidation of fragments occurs on time. However, this is possible only when structural integrity is recovered. Based on the analysis of the results, it should be noted that in cases of comminuted fractures in the ZAC area accompanied by bone defects, the use of biodegradable polymer plates is impractical as the sole method of fixing bone fragments, as it is necessary to restore the buttresses in this area. This is possible only by applying more rigid, non-resorbable bone plates for osteosynthesis. Polymer fixation plates and screws (EPU-GAP-LEV) should then be used as an adjunct; they simultaneously function as a “depot” to improve conditions for wound healing and prevent inflammatory complications in the postoperative period. Thus, for 41 patients, titanium plates and screws were used in the fracture areas, while polymer retainers (EPU-GAP-LEV) were utilized as additional fixators. In these cases, bone defects of various sizes were observed following the removal of free fragments that had lost contact with the periosteum; by the time of follow-up (6 months after sur-

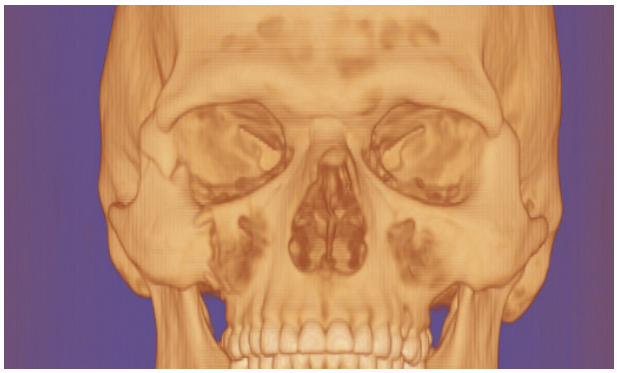

Fig. 1. 3D-CT reconstruction of the facial skeleton of patient S. (post-traumatic condition)

Fig. 2. Intraoperative stages:
A — Polymer osteosynthesis in the area of the zygomatico-frontal suture using EPU-GAP-LEV plates and screws.
B — Polymer osteosynthesis in the ZAC area using EPU-GAP-LEV plates and screws.

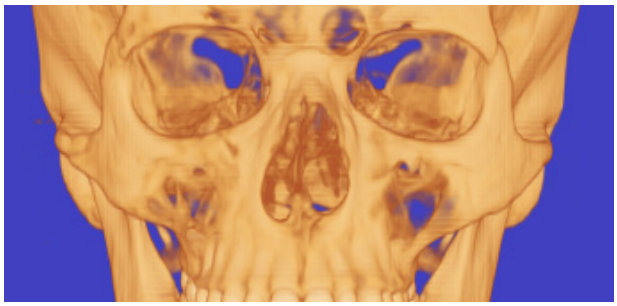

Fig. 3. 3D-CT of the patient 6 months after surgery, showing complete anatomical restoration

gery), these areas were not yet filled with bone tissue. Radiographic density in these regions averaged 138 ± 59 HU, which was 5–16 times lower than on the healthy, unaffected side.

In the postoperative period, all patients were administered a standard course of anti-inflammatory therapy.

Clinical Example 1

Patient S., 30 years old, was admitted for treatment as an emergency. The patient presented with a traumatic fracture of the right zygomatic bone with displacement ***(Fig. 1)***.

After clinical and radiographic examinations, the operation was performed: repositioning and polymer osteosynthesis (EPU-GAP-LEV) of the right zygomatic complex. Using an intraoral approach and direct access to the right zygomatico-frontal suture, repositioning of the ZC was carried out, followed by its fixation with EPU-GAP-LEV plates in the areas of the right zygomatico-frontal suture and the ZAC. The operation was completed with a revision and catheterization of the right maxillary sinus ***(Fig. 2)***.

The postoperative period was uneventful. The X-ray of the zygomatic complex confirmed the correct repositioning of bone fragments and the proper position of the plates and screws. The stitches were removed, and the patient was discharged from the hospital in satisfactory condition. A follow-up examination three months after the operation demonstrated the patient's full rehabilitation. The polymer plates in the osteosynthetic areas were not palpable.

Six months later, a control 3D-CT of the facial skeleton showed complete anatomical restoration of the affected area ***(Fig. 3)***. Bone mineral density (BMD) values in the polymer osteosynthesis (EPU-GAP-LEV) area approached those of the unaffected bones on the symmetrical side (879 ± 124 HU ver-

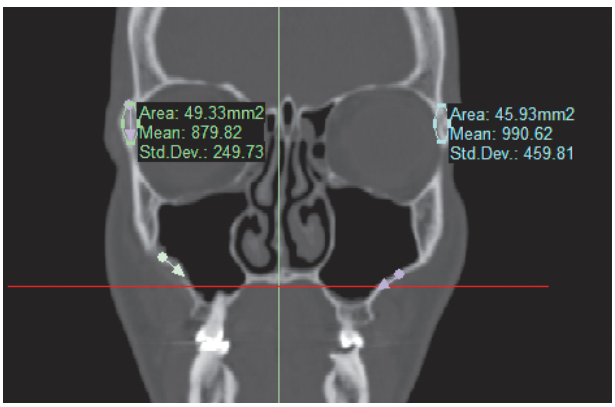

Fig. 4. Analysis of bone density in the area of fragment fusion 6 months after surgery

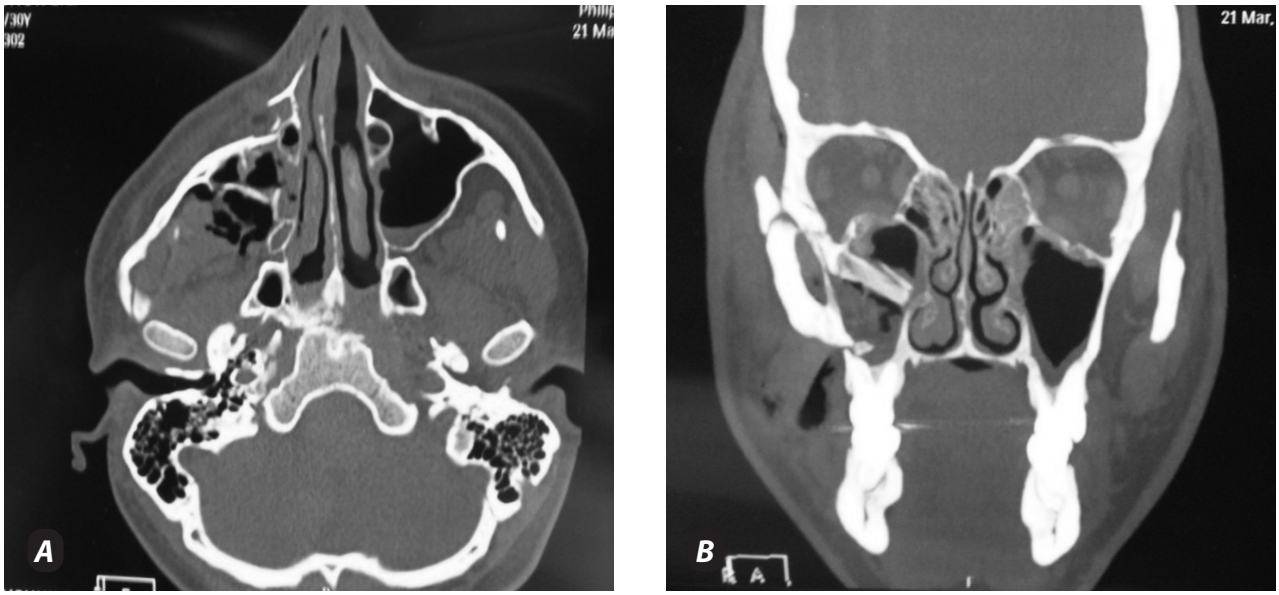

Fig. 5. Patient S. Diagnosis: Traumatic fracture of the right ZC with displacement:
A — CT slice in axial projection. *B* — CT slice in coronal projection.

sus 951 ± 132 HU). This indicates the timeliness of all phases of bone tissue regeneration, including mineralization and remodeling ***(Fig. 4)***.

Comparison of the bone mineral density in the polymer osteosynthesis area and the symmetrical unaffected areas (in this MSCT slice, the mineral bone density value in the polymer osteosynthesis area was 879.82 HU versus 990.62 HU on the unaffected side).

Clinical Example 2

Patient S., 28 years old, was admitted for emergency treatment. The patient had a traumatic fracture of the right zygomatic complex with displacement. He sought medical attention five days after the injury.

On the 3D-CT scan, disruptions of the integrity of the facial skeleton were determined, specifically a comminuted fracture of the right zygomatic complex involving the body of the ZC, the infraorbital rim, and the ZAC with displacement ***(Fig. 5)***.

After clinical and radiographic examinations, the operation was performed: repositioning and osteosynthesis of the right ZC. Using an intraoral approach and direct access, the ZC was repositioned, followed by fixation with an EPU-GAP-LEV plate at the ZC body.

Considering that the fracture was comminuted and that after the removal of free fragments, a small bone defect was formed (1.4 mm in length), there was a need not only to fix the bone fragments at this site but also to restore the buttresses. Therefore, fixation of the ZC body was carried out using the EPU-GAP-LEV plate, while in the zygomatic-temporal area (zygomatic process of the tem-

Fig. 6. Intraoperative stages for patient S.
A — Polymer osteosynthesis (EPU-GAP-LEV) on the ZC body. *B* — Titanium osteosynthesis in the ZAC area.

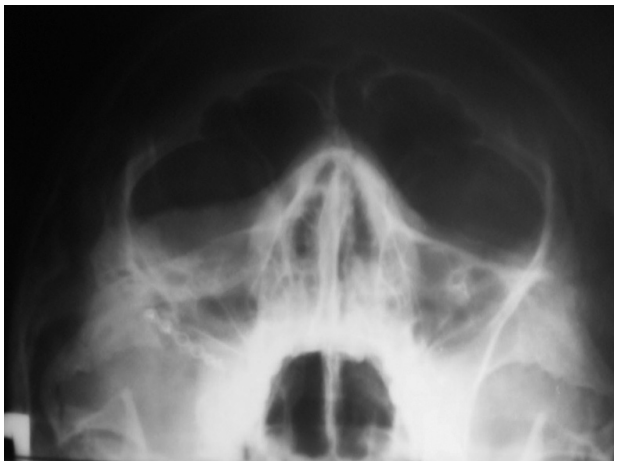

Fig. 7. Axial X-ray of the patient 7 days after surgery.

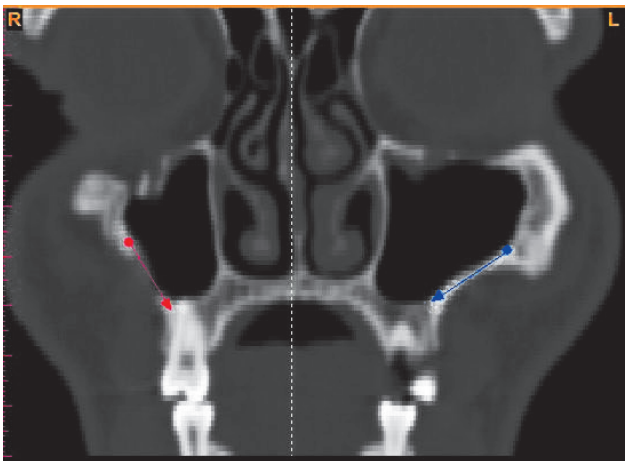

Fig. 8. MSCT of the facial bones of patient S., 28 years old, 6 months after osteosynthesis; visualization of the bone defect in the ZAC area

poral bone), a titanium bone plate and screws were used ***(Fig. 6)***. The operation was completed with a revision and catheterization of the right maxillary sinus.

The postoperative period was uneventful. The X-ray confirmed the correct position of the fragments ***(Fig. 7)***. Within 1 year of surgery, no complications were reported.

Fig. 7. Axial X-ray of patient 7 days after surgery. Six months after the operation, follow-up MSCT revealed complete consolidation of the fracture in all areas where bone fragments were in contact during osteosynthesis. In the ZAC area, a bone defect remained, which had been stabilized and bridged with a titanium bone plate ***(Fig. 8)***.

Conclusions

Analysis of the clinical cases demonstrated that the choice of fixation devices for osteosynthesis in the zygomatic complex area should be tailored to the specific injury. If the surgery reveals a bone defect and the buttress requires restoration, rigid non-resorbable fixators, such as titanium plates, should be used. In cases where the integrity of the zygomatic complex can be restored without bridging a defect, resorbable EPU-GAP-LEV bone plates and screws are recommended.

Prospects for Further Research

To evaluate the efficacy of resorbable EPU-GAP-LEV implants for osteosynthesis in other areas of the maxillofacial region.

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Consent for Publication. All authors have read and approved the final manuscript and provide their formal consent for its publication.

REFERENCES / ЛІТЕРАТУРА

1. Yemineni, B. C., Mahendra, J., Nasina, J., Mahendra, L., Shivasubramanian, L., & Perika, S. B.(2020). Evaluation of maximum principal stress, von mises stress, and deformation on 221surrounding mandibular bone during insertion of an implant: A three-dimensional finite element study. *Cureus*, 12(7): e9430. DOI: https://doi.org/10.7759/cureus.9430.
2. Varese, Ya. E. (2009). Indications for removing metallic mini plates in traumatology and reconstructive surgery maxillofacial. *Ukrainian Dental Almanac,* 12(2), 42–45.
3. Galatenko, N. A., Kuksin, A. M., Rozhnova, R. A., & Astapenko, O. O. (2008). Biodegrating action of bioactive material based on polyuretan-epoxy compositions as a carrier of drugs. *The polymer journal.* 2(30), 169–173. [Галатенко, Н. А., Куксін, А.М., Рожнова, Р.А., Астапенко, О.О. (2008). Біодеградуємий матеріал біоактивної дії на основі поліуретан-епоксидних композицій як носій лікарських речовин. Інститут хімії високомолекулярних сполук НАН України, *Полімер. журн.*, 30(2), 168–172]. [in Ukrainian]. URL: https://nasplib.isofts.kiev.ua/handle/123456789/7291.
4. Malanchuk, V. O., & Astapenko, O. O. (2013). Application of bioresorbable polymeric bioactive action miniplates for osteosynthesis in fractures of the zygomatic complex. *Herald of stomatology,* (4), 68–72.

5. Malanchuk, V. O., Astapenko, E. A., Galatenko, N. A., et al. (2013). Results of the study of physical and mechanical biodegrading polymer properties, used in reconstructive bone surgery. *Bulletin problems of biology and medicine,* 2(100), 304–308.

6. Malanchuk, V., Logvinenko, I., Malanchuk, T., & Tsilenko, O. (2011). Surgical dentistry and maxillo-facial surgery (Vol. 2). Logos.

7. Prathigudupu, R. S., Tiwari, R. V., Mathew, P., Roy, B., Sadique, S., & Tiwari, H. (2018). Mortality in Maxillofacial Trauma. A Review. *Saudi J Oral Dent Res*, 3(7), 219–23. DOI: https://doi.org/10.21276/sjodr.2018.3.7.3.

8. Tami D. DenOtter; Johanna Schubert. (2021). Hounsfield Unit. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing. Available from: https://www.ncbi.nlm.nih.gov/books/NBK547721/

9. Mehta R.; GP trainee, Chinthapalli K.; consultant neurologist. (2019). Glasgow coma scale explained. *BMJ*, 365: l1296. DOI: https://doi.org/10.1136/bmj.l1296.

10. Javali, R. H., Krishnamoorthy, Patil A., Srinivasarangan M., Suraj, Sriharsha. (2019). Comparison of Injury Severity Score, New Injury Severity Score, Revised Trauma Score and Trauma and Injury Severity Score for mortality prediction in elderly trauma patients. *Indian J Crit Care Med,* 23(2), 73–7. DOI: https://doi.org/10.5005/jp-journals-10071-23120.

11. Syed, I., Joshi, A., Desai, A. K., & Anehosur, V. (2020). Occlusal Analysis Using T-Scan in Patients with Condylar Fractures When Managed by Closed Method. *J Craniofac Surg,* 31(5), e451-e459. DOI: https://doi.org/10.1097/SCS.0000000000006449.

12. Rallis, G., Mourouzis, C., Papakosta, V., Papanastasiou, G., & Zachariades, N. (2006). Reasons for miniplate removal following maxillofacial trauma: a 4-year study. *J Craniomaxillofac Surg,* 34(7), 435–9. DOI: https://doi.org/10.1016/j.jcms.2006.07.001.

13. Aman, H., Shokri, T., Reddy, L. V., & Ducic, Y. (2019). Secondary management of midface fractures. *Facial Plast Surg,* 35(6), 640–4. DOI: https://doi.org/10.1055/s-0039-3399494.

14. Mast, G., Ehrenfeld, M., Cornelius, C. P., Tasman, A. J., & Litschel, R. (2015). Maxillofacial fractures: midface and internal orbit-Part II: Principles and surgical treatment. *Facial Plast Surg*, 31(4), 357–67. DOI: https://doi.org/10.1055/s-0035-1563693.

15. Rothweiler, R., Bayer, J., Zwingmann, J., Suedkamp, N. P., Kalbhenn, J., Schmelzeisen R, et al. (2018). Outcome and complications after treatment of facial fractures at different times in polytrauma patients. *J Craniomaxillofac Surg,* 46(2), 283–7. DOI: https://doi.org/10.1016/j.jcms.2017.11.027.

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