

Changing Trends in the Treatment of Zygomaticomaxillary Complex Fractures: A 12-Year Evaluation of Methods Used

Nicholas Zachariades, DDS, MD,* Michael Mezitis, DDS,†
and Demetrius Anagnostopoulos, MD‡

Purpose: The efficacy of the current methods for the treatment of fractures of the zygomaticomaxillary complex was evaluated.

Patients and Methods: One thousand two hundred seventy-seven patients with fracture of the zygomaticomaxillary complex and 196 patients with fractures of the zygomatic arch that were admitted between 1984 and 1995 were evaluated. One thousand one hundred fifty surgical procedures were performed, and in 401 cases, no operative treatment was considered necessary. The Gillie's approach was used in 514 cases, intraosseous wiring in 89 cases, bone plate osteosynthesis in 322 cases, Roger-Anderson pins in 180 cases, antral packing in 17 cases, and elevation with a hook in 28 cases.

Results: The best results were achieved with the use of semirigid fixation with miniplates applied at one or more sites of the fractured complex, occasionally used in combination with other methods such as Roger-Anderson pins.

Conclusions: Semirigid fixation with miniplates offers the most reliable method available today for the treatment of zygomatico-orbital complex fractures and has practically replaced every other method in our institution. The increased cost and occasionally the necessity to remove the hardware are the main disadvantages of the method.

In recent years the use of semirigid fixation has altered the traditional methods of treatment of fractures of the zygomaticomaxillary complex. Miniplates offer better stabilization at the fracture site, can be easily adapted, and are placed passively, allowing normal tension and flexion. In selected cases, they may even be placed under local anesthesia, thus reducing the hospitalization time and expense. Miniplates do not allow compression but are rigid due to the increased surface area between the screws and the bone, the increased three-dimensional stability, and the rigidity of the plate itself.¹ In addition, the new generations of bone plates are characterized by an improved ergonomics, such as multiplicity of design (ie, T, X, H, Y types) and decreased thickness. The introduction of

titanium has contributed to the malleability and biocompatibility of the hardware.^{2,3}

Wire fixation of zygomaticomaxillary fractures was used extensively in the past with satisfactory results, although some rotation or displacement of the fractured ends could not always be avoided, and the inclusion of small but occasionally important fragments could not always be achieved. The Gillie's approach has also been a very popular and simple method, particularly for recent fractures of the zygomatic arch and relatively simple zygomaticomaxillary complex fractures. However, this is a closed method and, if used alone, no fixation is provided. Roger-Anderson pin fixation is also a closed method in which it is difficult to properly align all the fragments. Among its advantages is the possibility to adjust the surgical result postoperatively.

Although the term *rigid internal fixation* is usually reserved for compression osteosynthesis, some authors use it for miniplates as well. However, we prefer to differentiate between the two techniques and use the term *semirigid* for miniplates.

The purpose of this study was to retrospectively review the modalities used to treat zygomaticomaxillary fractures over the past 12 years, to identify any changes in treatment modalities, and to interpret these trends.

Received from the General District Hospital Of Attica (K.A.T., formerly "Apostle Paul's" Accidents Hospital), Kifissia, Athens, Greece.

*Head, Oral and Maxillofacial Clinic.

†Senior Registrar, Oral and Maxillofacial Clinic.

‡Head, Neurosurgical Clinic.

Address correspondence and reprint requests to Dr Zachariades:
47 Thesseos St, 152 36 Pendeli, Greece.

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Patients and Methods

In the years 1984 through 1995, we admitted 7709 patients to the Oral and Maxillofacial Clinic of K.A.T. Hospital (Table 1). Of these admissions 4900 were trauma cases and included 1277 fractures of the zygomaticomaxillary complex and 196 fractures of the zygomatic arch. Patients were admitted on the basis of

1. Obvious disfigurement, functional handicaps such as inability to open the mouth and diplopia, as well as hypesthesia when associated with other signs and symptoms.
2. Gross displacement on standard radiographic examination regardless of the functional or aesthetic problems. Computerized tomography (CT), not available in the earlier years, is still not used routinely unless already provided by a transferring clinic to spare the patient the radiation exposure and avoid the cost. When gross fracture of the orbital floor is suspected, a tomogram or a CT scan is requested.
3. Extensive edema of the region, abrasions, lacerations, and so forth, regardless of the radiographic findings. These patients are admitted for observation and further evaluation when the local conditions improve.
4. Involvement of the eye of any kind that may cause concern regarding vision or cases in which the eye cannot be examined properly and further evaluation is considered necessary.
5. Neurologic compromise, which did not require admission to the Neurosurgical Clinic, in association with signs and symptoms of a zygomaticomaxillary fracture that probably does not need to be operated on.
6. Similar cases with other concomitant injuries such as chest and abdominal trauma. Such cases

are mainly admitted for further investigation by the maxillofacial and other clinics.

Of the 1473 cases, 1150 were operated on, and 401 were only kept for observation until the edema subsided and there was either no clinical indication for further treatment or associated conditions (such as neurologic problems) did not allow operative treatment. We also chose not to interfere surgically in cases in which mere hypesthesia with no concomitant aesthetic or other functional problems was present and there was not significant displacement of bone. In these cases, the condition usually resolved without surgical intervention.⁴

Results

A variety of methods were used over the years, and each had its advantages and disadvantages (Table 1, 2). In earlier years, the treatment of choice was the Gillie's approach. It was used mainly for fractures of the zygomatic arch and, in selected cases with no significant comminution, for fractures of the zygomaticomaxillary complex. The method was not always successful, because postoperative reduction was occasionally insufficient, and the zygomatic arch was not always elevated. Persistent sensory disturbances were not an uncommon finding, and a few cases had to be reoperated. In two cases, secondary coronoidectomy was necessary to facilitate opening the mouth. In certain cases when the result was not considered adequately stable the Gillie's approach was supplemented with Roger Anderson pins or with intraosseous wiring. In recent years, we only used the Gillie's approach for recent fractures of the zygomatic arch.

Roger Anderson pins were not always easy to apply, but they had the advantage of minor allowing postop-

Table 1. NUMBERS OF CASES TREATED AND THE METHODS USED

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Totals
Admissions	677	632	732	707	666	592	585	631	650	687	556	594	7,709
Trauma cases	455	434	505	448	442	380	335	361	430	420	369	321	4,900
Zygomatic maxillary fractures	125	146	135	122	101	116	89	98	120	80	79	66	1,277
Zygomatic arch fractures	20	14	17	13	23	14	22	14	14	23	9	13	196
Gillie's technique	88	115	87	65	46	37	27	24	9	13	1	2	514
Intraosseous wiring	11	13	15	16	18	9	3	0	3	1	0	0	89
Plating	0	0	0	2	3	17	48	61	65	42	43	41	322
Roger-Anderson pins	17	19	36	31	28	39	8	2	0	0	0	0	180
Antral packing	3	4	4	3	1	2	0	0	0	0	0	0	17
Hook	0	0	0	0	0	0	0	0	7	7	6	8	28
Nonoperative treatment	42	24	29	31	38	32	28	31	45	38	36	27	401

Table 2. ADVANTAGES AND DISADVANTAGES OF THE VARIOUS TREATMENT STRATEGIES

	Advantages	Disadvantages
Temporal (Gillie's) approach.	<ul style="list-style-type: none"> Easy method Fast method Reduced hospitalization No antibiotics needed for simple fractures Reduced cost No visible scar, as a rule 	<ul style="list-style-type: none"> Closed method Best results in simple fractures (ie, arch fractures) Inappropriate for old fractures Inappropriate for comminuted fractures Inability to fix the reduced fracture Increased relapse potential
Elevation with a hook	<ul style="list-style-type: none"> Easy method Fast method Reduced hospitalization No antibiotics needed Reduced cost 	<ul style="list-style-type: none"> Closed method Limited to simple fractures (ie, arch fractures) Inappropriate for zygomatico maxillary complex fractures Inability to fix the reduced fracture
External pin fixation	<ul style="list-style-type: none"> Possibility for postoperative modification Can be used in old fractures Average hospitalization Average cost Can supplement other methods 	<ul style="list-style-type: none"> Closed method Risky method Inaccurate method Some experience is required Inappropriate for very comminuted fractures Possibility of infection May leave scars Inconvenient to the patient Limited possibilities Possibility of infection
Intraoral approach	<ul style="list-style-type: none"> No visible scars 	<ul style="list-style-type: none"> Inaccurate method Possibility of overcorrection Questionable fixation Increased relapse potential Possibility of infection Unpleasant odor Possibility of an oroantral fistula Possibility of a second operation for removal Longer hospitalization Rarely, optic nerve injury Some experience required Leaves scars
Antral packing with gauze or balloon	<ul style="list-style-type: none"> Relatively easy method No visible scars Can be used in comminuted fractures Can be used in fractures of the anterior antral wall Can supplement intraosseous wiring of the lateral orbital rim 	<ul style="list-style-type: none"> Possibility of infection Unpleasant odor Possibility of an oroantral fistula Possibility of a second operation for removal Longer hospitalization Rarely, optic nerve injury Some experience required Leaves scars One approach is seldom adequate Anterior and posterior stripping of all sites Inappropriate for comminuted fractures Possibility of displacement on tightening Possibility of avulsion and loss of fragments Possibility of infection Possibility of ectropion Antibiotics usually required Increased surgical time Increased hospitalization Increased cost No postoperative modification possible Adequate experience required Longer incisions Leaves scars Increased surgical time Increased hospitalization Requires the most expensive hardware Possibility of infection Antibiotics usually required Possibility of ectropion No postoperative modification possible Patient may palpate the plates Removal of plates may be necessary
Intraosseous wiring	<ul style="list-style-type: none"> Accurate method Possibility of fixation Can be applied in old fractures 	<ul style="list-style-type: none"> Leaves scars One approach is seldom adequate Anterior and posterior stripping of all sites Inappropriate for comminuted fractures Possibility of displacement on tightening Possibility of avulsion and loss of fragments Possibility of infection Possibility of ectropion Antibiotics usually required Increased surgical time Increased hospitalization Increased cost No postoperative modification possible Adequate experience required Longer incisions Leaves scars Increased surgical time Increased hospitalization Requires the most expensive hardware Possibility of infection Antibiotics usually required Possibility of ectropion No postoperative modification possible Patient may palpate the plates Removal of plates may be necessary
Bone plating	<ul style="list-style-type: none"> Stability in three planes Fewer approaches required Best fixation Appropriate method for comminuted fractures Appropriate method for anterior antral wall fractures Can be used in old fractures 	<ul style="list-style-type: none"> Leaves scars Increased surgical time Increased hospitalization Requires the most expensive hardware Possibility of infection Antibiotics usually required Possibility of ectropion No postoperative modification possible Patient may palpate the plates Removal of plates may be necessary

erative modifications, when required, without the need of anesthesia. They were often useful in combination with other methods.

Elevation with a hook was recently introduced in

our clinic as an easy and quick method for the elevation of fractures of the zygomatic arch and, in selected cases, of the zygomaticomaxillary complex. As the method is closed, there have been cases in

which postoperative radiographic examination showed inadequate elevation, and in two cases of arch fracture reoperation was necessary.

Antral packing with gauze or a balloon was occasionally used in very comminuted fractures (particularly with anterior antral wall comminution) in which meticulous, direct, anatomic, reduction of the fragments was impossible and could result in partial loss of bone due to periosteal stripping and compromised blood supply. Antral packing was sometimes used to supplement intraosseous wiring of the frontozygomatic suture or in combination with Roger Anderson pins, but it is an inaccurate, closed process. There is a risk of forcing bone fragments into the optic nerve,⁵ and the introduction of a great quantity of foreign material into the maxillary sinus will frequently cause chronic sinusitis. We were seldom satisfied with the long-term results obtained with antral packing because the reduction sometimes collapsed after removal of the packing, diplopia persisted, and the odor of the pack often annoyed the patient. Postoperative sensory disturbances were also noted, but no antra-oral fistulae were seen. Premature rupture of a Foley catheter used as a balloon occurred once.

Regardless of the delay in treatment, elevation from the lateral orbital rim and intraosseous wiring gradually became the method of choice in our clinic for fractures of the zygomaticomaxillary complex until the introduction of bone plates. It was occasionally supplemented with intraosseous wiring of the infraorbital rim, depending on the intraoperative clinical evaluation after the elevation. In very comminuted fractures of the infraorbital rim, we found that intraosseous wiring often resulted in loss of bone as well as periosteum. In several cases, when the result was still not satisfactory, Roger Anderson pins were added to further stabilize the zygomaticomaxillary complex or fragments that were not included in the intraosseous wiring. Until the introduction of bone plates, intraosseous wiring of the fragments (with or without the supplementation of Roger Anderson pins) was the most reliable method for stabilizing fractures of the zygomaticomaxillary complex.

With the introduction of miniplates, both the lateral and infraorbital rim (and in certain cases the zygomatic buttress and even the zygomatic arch) were fixed and supplementation with Roger Anderson pins became rare. Miniplates allowed reduction and fixation in three planes.

Discussion

The zygomaticomaxillary complex is an essential element of the facial configuration. Because of its location, it is subjected to trauma more often than any other element of the face except the nose. Although

some injuries will involve an isolated orbital rim or antral wall fracture, most injuries will include the zygomatic bone, and thus the term "zygomaticomaxillary." The consequences of such injuries may involve ocular function, orbital shape, facial aesthetics, and mandibular mobility.⁶⁻⁹

The stability of such fractures after reduction is often dependent on the age of the fracture. Thus, repositioning should take place as soon as possible.⁹⁻¹² Conversely, assessment of enophthalmos, diplopia and/or facial asymmetry is made difficult by periorbital edema and hematoma,^{3,13} which may obliterate the skin creases and alter the facial appearance. Consequently, we believe that early treatment of such fractures, as is often advocated, is open to question. The method of treatment varies,¹⁴ depending on the type of fracture, the delay in treatment, the associated injuries (particularly of the globe), the general condition of the patient, and the surgeon's armamentarium and experience.^{5,15,16} Fractures without displacement do not require surgery.¹⁷⁻¹⁹ In fact, Ellis et al²⁰ reported that 23% of their 2067 zygomaticomaxillary fractures did not receive surgical intervention. We, nevertheless, share the opinion of others^{10,21} that all fractures requiring surgery should also have some form of fixation. This is particularly true in displaced, unstable cases with wide separation, displacement of the frontozygomatic suture, and rotation.²² The same can be said about comminuted fractures, although the extent of comminution is not always evident from the radiographs or even from computed tomography.

There are many methods to treat zygomatico-orbital fractures (Table 2). Although simple methods such as elevation with a hook or the temporal approach are often associated with fewer complications, they are generally used in less complex cases. Contemporary surgical repair relies heavily on open reduction and semirigid internal fixation. External fixation devices, used in the mid-1980s, and closed repair are now used infrequently,^{23,24} because such methods do not always provide adequate results.²⁴

In our hospital we have been treating most fractures of the facial skeleton in Greece²⁵ since the early 1960s, and we have had the opportunity to use every available method. It is evident from our data (Table) that in the earlier years we used the Gillie's approach quite extensively (45% of the approaches), whereas later intraosseous wiring of the lateral and inferior orbital rim (8% of the cases) as well Roger Anderson pins (used in 16% of the cases either alone or to supplement other methods) were the methods of choice. Antral packing with gauze or a balloon was used in 1.5% of the cases. In recent years, we introduced bone plating, which is now used almost exclusively (28% of the cases) with much better results.

References

- Berman PD, Jacobs JB: Miniplate fixation of zygomatic fractures. *Head Neck Surg* 13:424, 1991
- Freidel M, Gola R: Fractures complexes de l' etage moyen de la face et de l' etage anterieur de la base du crane. XXXIle Congres de Stomatologie et de chirurgie maxillo-faciale et plastique de la face. *Rev Stomatol Chir Maxillofac* 92:285, 1991
- Saboue J, Paoli JR, Gargouri F, et al: Osteosynthese par micro-plaques dans les fractures du plancher de l' orbite. *Rev Stomatol Chir Maxillofac* 94:9, 1993
- Zachariades N, Papavassiliou D, Papademetriou J: The alterations in sensitivity of the infraorbital nerve following fractures of the zygomatico-maxillary complex. *J Craniomaxillofac Surg* 18:315, 1990
- Zachariades N, Papavassiliou D, Christopoulos P: Blindness following facial trauma. *Oral Surg* 81:34, 1966
- Archer WH: *Oral and Maxillofacial Surgery*, vol II (ed 5). Philadelphia, PA, Saunders, 1975, pp 1274-1290
- Thoma KH: *Oral Surgery*, vol I (ed 5). St Louis, MO, Mosby, 1969, pp 494-515
- Rowe NL, Williams LJ: *Maxillofacial Injuries*, vol I. Edinburgh, Scotland, Churchill Livingstone, 1985, pp 435-537
- Lund K: Fractures of the zygoma: A follow-up study on 62 patients. *J Oral Surg* 29:557-560, 1971
- Foster CA, Sherman JE: *Surgery of Facial Bone Fractures*. New York, NY, Churchill Livingstone, 1987, pp 123-146
- Alling CC, Osborn DB: *Maxillofacial Trauma*. Philadelphia, PA, Lea & Febiger, 1988, pp 286-371
- Schilli W, Niederdellman H: Internal fixation of zygomatic and midface fractures by means of miniplates and lag screws, *in* Kruger E, Schilli W: *Oral and Maxillofacial Traumatology*. Chicago, IL, Quintessence, 1986, pp 177-196
- Chong R, Kaban LB: Fractures of the zygomatic complex. *J Oral Maxillofac Surg* 44:283, 1986
- Kawano Y: Three dimensional analysis of the face in respect of zygomatic fractures and evaluation of the surgery with the aid of Moire topography. *J Craniomaxillofac Surg* 15:68, 1987
- Zachariades N: Pre- and post-operative complications of fractures of the zygomaticomaxillary complex and their treatment. *Odonto-stomatol Progr* 45:261, 1991
- Zachariades N, Mezitis M, Michelis A: Posttraumatic osteomyelitis of the jaws. *Int J Oral Maxillofac Surg* 22:328, 1993
- Fischer-Brandeis E, Dielert E: Treatment of isolated lateral midface fractures. *J Maxillofac Surg* 12:103, 1984
- Kruger E: Treatment of lateral midface fractures, *in* Kruger E, Schilli W: *Oral and Maxillofacial Traumatology*. Chicago, IL, Quintessence, 1986, pp 158-176
- Mustarde JC: *Repair and Reconstruction in the Orbital Region* (ed 3). Edinburgh, Scotland, Churchill Livingstone, 1991, pp 361-375
- Ellis E, El Attar A, Moos KF: An analysis of 2,067 cases of zygomatico-orbital fractures. *J Oral Maxillofac Surg* 43:417, 1985
- De Man K, Bax WA: The influence of the mode of treatment of zygomatic bone fractures on the healing process of the infraorbital nerve. *Br J Oral Maxillofac Surg* 26:419, 1988
- Kaastad E, Freng A: Zygomatico-maxillary fractures. *J Craniomaxillofac Surg* 17:210, 1989
- Marciani RD: Management of midface fractures: Fifty years later. *J Oral Maxillofac Surg* 51:960, 1993
- Pozatek ZW, Kaban LB, Guralnick WC: Fractures of the zygomatic complex: An evaluation of surgical management with special emphasis on the eyebrow approach. *J Oral Surg* 31:141, 1973
- Zachariades N, Papavassiliou D: The pattern and aetiology of maxillofacial injuries in Greece: A retrospective study of 25 years and a comparison with other countries. *J Craniomaxillofac Surg* 18:251, 1990

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56:1156-1157, 1998

Discussion

Changing Trends in the Treatment of Zygomaticomaxillary Complex Fractures: A 12-Year Evaluation of Methods Used

Raymond J. Fonseca, DMD

Dean and Professor of Oral and Maxillofacial Surgery, University of Pennsylvania, Philadelphia, Pennsylvania

The introduction of rigid fixation techniques has significantly changed the options for the management of zygomaticomaxillary complex (ZMC) fractures. In the article entitled "Changing Trends in the Treatment of Zygomaticomaxillary Complex Fractures," the authors describe the evolution of the procedures for treatment of these injuries from wire to miniplate semirigid fixation techniques. The development of plate and screw fixation techniques has made previous methods of fixation obsolete.¹ There is no better method of providing stable fixation to an unstable ZMC fracture, in three planes of space, than to secure it rigidly with bone plates.

Rarely do we have the opportunity to review such an extensive series of patients with a variety of treatment modalities. Unfortunately, the authors failed to expand on their findings. Inclusion of specifics, such as the size and number of plates, and postoperative complications, would have added significantly to our understanding of the treatment of these injuries. For instance, the use of as thin a plate as possible has been found to be a sound principle in the management of fractures in the periorbital area. The soft tissue overlying the orbital rim is very thin, thus necessitating a thin plate to prevent visibility. The choice of a 1.0-mm microplate versus a 1.5-mm or 2.0-mm miniplate is based on the location and displacement of the fracture. The muscular forces acting on the ZMC are much weaker than those exerted on the mandible. Therefore, the thinner, more adaptable, microplates may be used. The low profile of the miniplates makes their placement at the frontozygomatic suture, infraorbital rim, and zygomatic arch advantageous, whereas the miniplate is indicated for use in fixation of the zygomaticomaxillary buttress. When the authors refer to miniplates, do they truly mean the 1.5-mm or 2.0-mm variety, or are they also using microplates?