Analysis of Orbital Bone Fractures: A 12-Year Study of 391 Patients

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Abstract: This retrospective study evaluates 391 patients with orbital bone fractures from a variety of accidents that were treated at the department of Plastic and Reconstructive Surgery, Inha University Hospital, Incheon, South Korea, between February 1996 and April 2008. The medical records of these patients were reviewed and analyzed to determine the clinical characteristics and treatment of the orbital bone fractures.

The following results were obtained. The mean age of the patients was 31.1 years, and the age range was 4 to 78 years. The most common age group was the third decade of life (32.5%). There was a significant male predominance in all age groups, with a ratio of 4.43:1. The most common etiology was violent (assault) or nonviolent traumatic injury (57.5%) followed by traffic accidents (15.6%) and sports injuries (10.7%).

The most common isolated orbital bone fracture site was the orbital floor (26.9%). The largest group of complex fractures included the inferior region of the orbital floor and zygomaticomaxilla (18.9%). Open reduction was performed in 63.2% of the cases, and the most common fracture reconstruction material was MEDPOR (56.4%) followed by a resorbable sheet (41.1%). The postoperative complication rate was 17.9%, and there were no statistically significant differences among the reconstruction materials with regard to complications. During follow-up, diplopia, hypoesthesia, and enophthalmos occurred as complications; however, there was no significant difference between porous polyethylene sheet (MEDPOR) and resorbable sheet groups.

Long-term epidemiological data regarding the natural history of orbital bone fractures are important for the evaluation of existing preventative measures and for the development of new methods of injury prevention and treatment.

Key Words: Orbital fractures, diplopia, hypoesthesia, enophthalmos

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Fractures of the orbital wall are common injuries.[1] During their natural course, herniated orbital tissue can be trapped in a fractured opening or herniated through the maxillary or ethmoidal sinus, causing diplopia and enophthalmos, resulting in disfigurement.[2] Failure of prompt recognition and treatment of these injuries may result in significant morbidity.[3] A comprehensive knowledge of the characteristics of this patient population is valuable for their management. Unfortunately, much of the current literature on orbital floor fractures is either out of date or based on small groups of patients.[3]

In attempt to assess the extent and etiology of orbital bone fractures, we gathered information on a large number of clinically relevant variables and performed statistical analyses to provide clinically useful data. We investigated and analyzed the incidence, type, etiology, injury pattern of hard tissue, and associated injuries, as well as the treatment and outcome of orbital bone fractures.

An understanding of the cause, severity, and temporal distribution of facial trauma might aid in establishing clinical and research priorities for effective treatment and prevention of these injuries.[4] The epidemiological trends with regard to specific injuries are always changing and are reflections of the demographic and social behaviors and the time the population was studied. This constant flux makes periodic review a useful and valuable exercise to monitor the changing trends.[5]

The purpose of this study was to evaluate the natural history of orbital bone fractures in 391 cases over 12 years at the Department of Plastic Surgery, Inha University Hospital, Incheon metropolitan city, South Korea.

PATIENTS AND METHODS

The medical records of patients seeking treatment for orbital bone fractures were reviewed at the Department of Plastic and Reconstructive Surgery, Inha University Hospital, Incheon metropolitan city, South Korea. The study population consisted of 391 severely injured patients with orbital bone fractures from February 1996 to June 2008. The parameters assessed were age, sex, time of injury, etiology, injury types, and associated injuries, in addition to the type of fracture and treatment modality. The orbital bone fractures were classified as isolated or complex fractures for most patients. The isolated orbital bone fractures included orbital floor, medial, roof, and lateral bone fractures. The complex fractures were subclassified into 5 types according to the anatomic direction from the orbit and the extension from an adjacent area, which were inferior, medial, superior, lateral, or other locations (Table 1). In addition, the complications and follow-up were analyzed to investigate the data on the postoperative outcome with 2 synthetic orbital implants: porous polyethylene (MEDPOR; Porex Surgical Inc, Newman, GA) and the resorbable sheet (Inion CPS; Inion Oy,

TABLE 1. Classification of Orbital Bone Fractures

Fracture	Types	Location	No. Cases	%
Isolated			184	47.1
		Floor	105	26.9
		Medial	52	13.3
		Roof	4	1.0
		Lateral	3	0.8
		Floor and medial	20	5.1
Complex			207	52.9
	Inferior		152	38.9
		Zygomaticomaxilla and orbital floor	74	18.9
		Zygomaticomaxilla, orbital floor, and nasal	64	16.4
		Orbital floor and nasal	14	3.6
	Medial		25	6.4
		Orbit medial and nasal	25	6.4
	Superior		8	2.0
		Frontal and orbital roof	2	0.5
		Frontal, orbital roof, and nasal	6	1.5
	Lateral		17	4.3
		Orbit lateral and zygomatic arch	17	4.3
	Others		5	1.3
Total			391	100

Tampere, Finland). The χ^2 test was used for the statistical analysis, and $P < 0.05$ was considered statistically significant.

RESULTS

Demographic Distribution

This retrospective study of 391 cases included 319 males and 72 females, aged 4 to 78 years (mean age, 31.1 years), with orbital bone fractures (Table 2). The highest frequency of orbital bone fractures was in the age group 21 to 30 years (n = 127, 32.5%), followed by 31 to 40 years (n = 76, 19.4%) and 11 to 20 years (n = 75, 19.2%) (Table 2). There was a significant male predominance in all age groups, and the overall ratio of males to females was 4.43:1.

The analysis of the annual incidence revealed that both the absolute number and the proportion of facial injuries peaked in 2006

TABLE 2. Distribution According to Age and Sex

Age, y	Male	Female	No. Cases (%)
0 –10	14	3	17 (4.3)
11–20	73	2	75 (19.2)
21–30	103	24	127 (32.5)
31–40	61	15	76 (19.4)
41–50	39	19	58 (14.8)
51–60	20	7	27 (6.9)
>60	9	2	11 (2.8)
Total no. cases (%)	319 (81.6)	72 (18.4)	391 (100)

TABLE 3. Annual Incidence

Year	No. Cases	%
1996	8	2.0
1997	34	8.7
1998	32	8.2
1999	31	7.9
2000	27	6.9
2001	42	10.7
2002	42	10.7
2003	16	4.1
2004	17	4.3
2005	30	7.7
2006	50	12.8
2007	33	8.4
2008	29	7.4
Total	391	100

(Table 3). The monthly incidence was relatively constant; however, orbital bone fractures were slightly more common during the month of December (n = 45, 11.5%) (Table 4).

The most common causes of orbital bone fractures were violent (assault) or nonviolent traumatic injury (n = 225, 57.5%), traffic accidents (n = 61, 15.6%), sports injuries(n = 42, 10.7%), slip or fall (n = 34, 8.7%), work-related injuries (n = 23, 5.9%), and others (n = 6, 1.5%) (Table 5). The most common sport associated with injury was soccer (Table 5).

In 119 (30.4%) of the 391 patients, the orbital bone fractures were associated with other injuries (Table 6). Head and neck injuries were the most common isolated injuries associated with orbital bone fractures (80.7%) (Table 6). Among the patients with injuries to the head and neck area, most had brain injuries including the cranial blood vessels with altered levels of consciousness, cervical spine injuries, or optic nerve injury. Some patients (4.3%) had more than 1 type of associated injury including other bone fractures (Table 7). The most common isolated fracture associated with orbital bone fractures was a skull fracture (22.2%) (Table 7). In 95 (24.3%) of 391 patients, the orbital bone fractures were associated with other

TABLE 4. Monthly Distribution

Month	No. Cases	%
1	37	9.5
2	27	6.9
3	35	9.0
4	32	8.2
5	38	9.7
6	29	7.4
7	35	9.0
8	24	6.1
9	26	6.6
10	33	8.4
11	30	7.7
12	45	11.5
Total	391	100

TABLE 5. Causes of Orbital Bone Fractures

Causes	No. Cases	%
Trauma	225	57.5
Violence (+): assault	160	40.9
Violence (−): injury	65	16.6
Traffic accident	61	15.6
Sport	42	10.7
Soccer	15	3.8
Baseball	10	2.6
Basketball	5	1.6
Skiing or snowboarding	3	0.8
Martial arts	1	0.3
Others	8	2.0
Slip or fall down	34	8.7
Work related	23	5.9
Others	6	1.5
Total	391	100

TABLE 6. Associated Injuries

Location	No. Cases	%
Head and neck	96	80.7
Trunk	11	9.2
Lower extremity	6	5.0
Upper extremity	6	5.0
Total	119	100

TABLE 7. Associated Bone Fractures

Location	No. Cases	%
Skull	4	23.5
Upper extremity	3	17.6
Pelvis	3	17.6
Lower extremity	2	11.8
Clavicle	2	11.8
Spine	2	11.8
Rib	1	5.9
Total	17	100

TABLE 8. Associated Soft-Tissue Injuries

Location	No. Cases	%
Face and neck	83	87.4
Scalp	5	5.3
Upper extremity	3	3.2
Trunk	2	2.1
Lower extremity	2	2.1
Total	95	100

TABLE 9. Treatment Modalities for Orbital Bone Fractures

Treatment Modalities	No. Cases	%
Open reduction	247	63.2
Conservative	144	36.8
Total	391	100

TABLE 10. Time Interval Between Accident and Surgical Treatment for Orbital Bone Fractures

Interval	No. Cases	%
<3 d	47	19.0
<1 wk	136	55.0
<2 wk	53	21.5
<3 wk	10	4.0
>3 wk	1	0.4
Total	247	100

TABLE 11. Hospital Stay

Weeks	No. Cases	%
<1	181	48.3
1–2	134	35.7
2–3	27	7.2
3–4	16	4.3
>4	17	4.5
Total	375	100

TABLE 12. Soft-Tissue Approaches

Approaches	No. Cases	%
Subciliary	184	74.5
Wound	40	16.2
Bicoronal	7	2.8
Transconjunctival	5	2.0
Others	11	4.5
Total	247	100

TABLE 13. Materials Used for Reconstruction

Materials	No. Cases	%
MEDPOR	114	56.4
Resorbable sheet	83	41.1
Bone graft	5	2.5
Total	202	100

TABLE 14. Signs and Symptoms at Presentation Preoperatively Associated With Orbital Bone Fractures Among the 3 Reconstruction Materials

Physical Examination	MEDPOR	Resorbable Sheet	Bone Graft	Others*	Total No. Cases (%)
Diplopia	113	81	5	42	241 (61.6)
Hypoesthesia	102	80	5	14	201 (51.4)
Enophthalmos	98	78	5	0	181 (46.3)
Limitation of ocular movement	38	27	4	0	69 (17.6)
Others	114	83	5	87	289 (73.9)

*Include patients with conservative treatment. Their signs and symptoms improved without surgery.

soft-tissue injuries (Table 8). The associated injuries were most commonly soft-tissue injuries of the head and neck (87.4%) (Table 8).

Classification of Orbital Bone Fractures and Treatment

One half of the cases were isolated injuries (n = 184, 47.1%), and the others were complex injuries (n = 207, 52.9%) (Table 1). Orbital floor fractures were the most common (n = 105, 26.9%), followed by orbit medial wall fractures (n = 52, 13.3%) (Table 1). Zygomaticomaxilla and orbital floor fractures were the most common type of complex injuries (n = 74, 18.9%) (Table 1). For the complex injuries, the inferior region had the largest frequency of fractures (n = 152, 38.9%) (Table 1).

The average defect size of the orbital floor was 14.7 × 17.7 mm, and that of the orbit medial wall was 18.3 × 12.8 mm. An open-reduction procedure was performed in 63.2%, and no surgical intervention in 36.8% (Table 9). About two thirds of the orbital bone fractures were treated by open-reduction procedures. The orbital bone reduction was carried out, on average, 5.4 days after injury, and most had surgery within 1 week (55%) (Table 10). The average hospital stay for the patients with an orbital bone fracture was 9.9 days; most were discharged from the hospital within 2 weeks (84.0%) (Table 11).

For the open-reduction procedure, various soft-tissue approaches were used to meet the requirements of adequate fracture exposure and reduction. The most commonly used approach was the subciliary approach (74.5%) (Table 12). The materials for reconstruction included MEDPOR (56.4%), a resorbable sheet (41.1%), and a bone graft (2.5%) (Table 13).

TABLE 16. Follow-Up of the Postoperative Signs and Symptoms of Orbital Bone Fractures Between 2 Reconstruction Materials (MEDPOR and Resorbable Sheet)

Physical Examination	Time	MEDPOR	Resorbable Sheet
Diplopia	Presurgery	113 (100%)	81 (100%)
	Immediately postsurgery	112 (99.1%)	79 (97.5%)
	1 mo	64 (56.6%)	39 (48.1%)
	3 mo	34 (30.1%)	19 (23.5%)
	6 mo	19 (16.8%)	9 (11.1%)
	12 mo	4 (3.5%)	2 (2.5%)
Hypoesthesia	Presurgery	102 (100%)	80 (100%)
	Immediately postsurgery	101 (99.0%)	78 (97.5%)
	1 mo	36 (35.3%)	26 (32.5%)
	3 mo	16 (15.7%)	8 (10.0%)
	6 mo	7 (6.9%)	2 (2.5%)
	12 mo	1 (1.0%)	0 (0%)
Enophthalmos	Presurgery	98 (100%)	78 (100%)
	Immediately postsurgery	22 (22.4%)	20 (25.6%)
	1 mo	3 (3.1%)	6 (7.7%)
	3 mo	1 (1.0%)	2 (2.6%)
	6 mo	0 (0%)	1 (1.3%)
	12 mo	0 (0%)	0 (0%)

Complications and Prognosis

On physical examination before surgery, diplopia was the most common (61.6%) associated complication, followed by hypoesthesia (51.4%), enophthalmos (46.3%), and limitation of ocular movement (17.6%) (Table 14). The cases were analyzed according to the reconstruction materials (Table 14). Periorbital ecchymosis, subconjunctival hemorrhage, periorbital swelling, and tenderness were common signs or symptoms on presentation before

TABLE 15. Comparison of Postoperative Complications Associated With Orbital Bone Fractures Among the 3 Reconstruction Materials

Complications	MEDPOR	Resorbable Sheet	Bone Graft	Total	*P*
Diplopia*	19 (54.3%)	15 (45.5%)	1 (50.0%)	35 (50%)	>0.05
Hypoesthesia*	9 (25.7%)	11 (33.3%)	0 (20.0%)	20 (28.6%)	>0.05
Hematoma	2 (5.7%)	2 (6.1%)	1 (50.0%)	5 (7.1%)	>0.05
Limitation of ocular movement*	1 (2.9%)	2 (6.1%)	0 (0%)	3 (4.3%)	>0.05
Enophthalmos*	1 (2.9%)	1 (3.0%)	0 (0%)	2 (2.9%)	>0.05
Infection	1 (2.9%)	1 (3.0%)	0 (0%)	2 (2.9%)	>0.05
Others	2 (5.7%)	1 (3.0%)	0 (0%)	3 (4.3%)	>0.05
Total	35 (100%)	33 (100%)	2 (100%)	70 (100%)	

*Values presented are number of aggravated signs and symptoms compared with before the surgery.

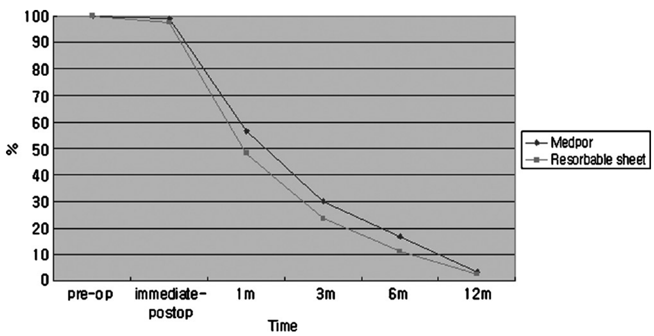

FIGURE 1. Prognosis of diplopia.

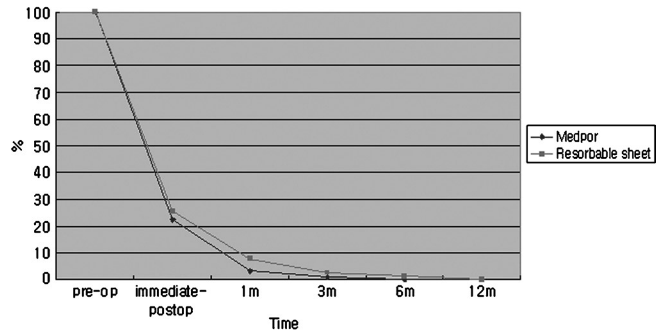

FIGURE 3. Prognosis of enophthalmos.

surgery (73.9%). The postoperative complication rate was 17.9%, and the most common complication was diplopia (50.0%), followed by hypoesthesia (28.6%), hematoma (7.1%), limitation of ocular movement (4.3%), enophthalmos (2.9%), and infection (2.9%) (Table 15). The postoperative complications were compared with those before surgery. There was no statistically significant difference found among the 3 reconstruction materials in the number of complications ($P > 0.05$) (Table 15).

In the follow-up of diplopia, about half of the patients presenting with diplopia improved during the first month of follow-up, and most of them were improved by 1 year in both the MEDPOR and resorbable sheet groups (Table 16; Fig. 1). In the follow-up of hypoesthesia, most patients were improved by 6 months (93.1%) in the MEDPOR group and 3 months (90.0%) in the resorbable sheet group (Table 16; Fig. 2). Follow-up of enophthalmos showed that 96.9% and 92.3% improved by 1 month in the MEDPOR and resorbable sheet groups, respectively (Table 16; Fig. 3). All patients were improved by 6 months of follow-up in the MEDPOR group and 1 year in the resorbable sheet group.

DISCUSSION

Orbital bone fractures are common injuries.[1] The primary objective of the surgical reconstruction of orbital bone fractures is achieved by the release of entrapped soft-tissue contents, by bridging the defect with autogenous or alloplastic material and by the restoration of the original anatomy and the orbital volume.[6] The study population evaluated reflects the epidemiology of a particular illness or injury, as differences occur with geographic location, local demographics, and social behaviors.[5] Factors such as geographic region, socioeconomic status, and temporal factors can influence both the type and cause of facial injuries reported, for a given population,[4] and this makes meaningful comparisons between epidemiological reviews difficult.

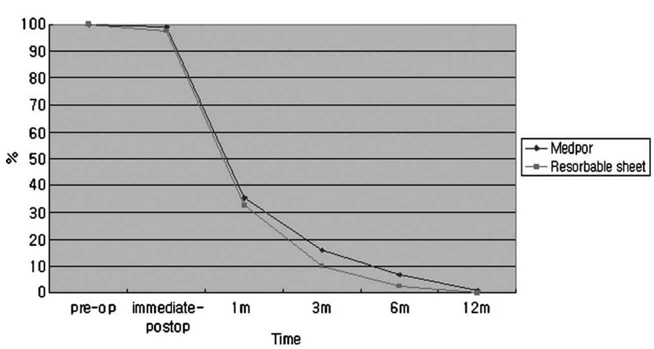

FIGURE 2. Prognosis of hypoesthesia.

The increasing prevalence of facial bone injuries emphasizes the necessity for epidemiological surveys to determine optimal prevention strategies and patient management. Such data can inform clinicians on the causes and incidence of orbital bone fractures. Long-term collection and analysis of epidemiological data regarding orbital fractures in severely injured patients are important steps for the evaluation of conventional preventative measures.[4] It is also necessary for the determination of trends to help guide the development and implementation of new methods for injury prevention.[4]

The results of this study provide relevant and current demographic information on a large series of surgically treated orbital bone fractures. The results of this study showed high morbidity associated with orbital bone fractures in the 21- to 30-year age group, followed by the 31- to 40-year age group, consistent with previously published results.[7,8] As expected, we found a male predominance among all injuries and ages; the highest-risk group was the young male patients. As in previous reports,[9,10] young boys were at highest risk for orbital bone fractures and for trauma, in general, presumably because of the propensity of this group to engage in high-risk activities.[11] The annual incidence and the monthly frequency of orbital bone fractures were relatively stable.

Our results showed that violent (assault) or nonviolent traumatic injuries remain the leading cause of orbital bone fractures. The results of this study suggest that violence-prevention programs concentrating on both assault and self-inflicted injury may help decrease the frequency of facial trauma resulting from intentional injuries in this population. The second and third most common causes of orbital bone fractures in our study were traffic accidents and sports activities. These findings were consistent with those reported by Shere et al,[5] Converse et al,[10] and Koutroupas and Meyerhoff.[12]

Head and neck injuries were the most common isolated injuries associated with orbital bone fractures and included brain injuries with cranial blood vessel disruption and altered levels of consciousness, cervical spine injuries, and optic nerve injuries. The most common soft-tissue injury associated with orbital bone fractures was injury of the head and neck. This finding highlights the frequency with which the head and neck are involved in orbital bone fractures. Skull fractures were the most common fractures associated with orbital bone fractures, in addition to facial bone fractures. The high incidence of associated injuries (30.4%) emphasizes the importance of a complete and thorough assessment in patients who sustain facial trauma.

In the current study, the most commonly fractured isolated orbital bones were the orbital floor and the orbit medial wall. The most common complex fracture was that of the zygomaticomaxilla and orbital floor. The patterns of complex orbital bone fractures were classified by the anatomic direction from the orbit. Such fractures can, of course, extend to involve the associated wall of the orbit or, as in the case of the orbital roof, may be an extension from an adjacent area such as the superior rim or frontal bone. Orbital skeletal injuries are frequently associated with other significant injuries. The orbital rim was considered separately as comprising 4 regions, corresponding to the skeletal elements that define it: the frontal (superior), the nasoethmoidal (medial), the zygomatic (lateral), and the maxillary region (inferior). The inferior region was the most frequently involved in a fracture, occurring in about three fourths (70.9%) of the patients; this occurs because of its prominent location on the face. The medial region was involved in 24.8%, the superior region in 3.0%, and the lateral region in 5.1% of the patients with complex orbital bone fractures. The location of these fractures supports the notion that orbital bone fractures may be caused by force applied to the periorbital bony structures in addition to direct globe trauma.[13] In two thirds of the fractured orbital bones, an open reduction was performed (63.2%), and others had no surgical intervention (36.8%). The indications for surgery were determined by the presence of symptoms and signs such as continuous diplopia, aggravated enophthalmos, and limitation of ocular movement. Orbital bone reduction was carried out, on average, 5.4 days after the injury when swelling decreased; the average hospital stay was 9.9 days. The operative timing for repair of orbital fractures remains controversial. However, recently, most surgeons advocate early surgery for better postoperative results and decreased frequency of diplopia and enophthalmos.[2,6] Delayed surgery is not preferred because of soft-tissue scarring and contractures occurring around the fracture sites, greater risk of hemorrhage, and difficulty in isolating the infraorbital nerve; factors that make restoration more difficult to achieve.[2,6]

The most common surgical approach for open reduction of orbital bone fractures was the subciliary approach. Although the surgical approach via a subciliary incision risks postoperative lower lid retraction, we have not had any cases of postoperative lower lid retraction or ectropion, or the development of prominent scarring. Among the 247 patients treated by open reduction, 202 patients were treated with reconstruction materials. MEDPOR was the most commonly used material for the reconstruction surgery, followed by a resorbable sheet and bone grafts. Alloplastic implants offer an unlimited amount of material, reducing the surgical time and are relatively easily handled.[14] By contrast, autogenous materials and bone grafts are associated with certain disadvantages such as additional surgical time for the harvest of the bone graft, difficulties in handling and providing the appropriate contour and size, individual variation with regard to resorption, and the risk for donor-site morbidity.[14,15]

For the preoperative physical examination, the most common symptoms or signs on presentation were diplopia (n = 241, 61.6%), hypoesthesia (n = 201, 51.4%), enophthalmos (n = 181, 46.3%), and limitation of ocular movement (n = 69, 17.6%). Most had periorbital swelling, tenderness, ecchymosis, and subconjunctival hemorrhages. However, the absence of periorbital edema or ecchymosis does not rule out the presence of an orbital bone fracture. Therefore, meticulous examination is needed to properly diagnose the presence of an orbital bone fracture. After surgery, most of these symptoms or signs were improved; however, they were aggravated in a few patients. Postoperatively, diplopia (n = 35, 50%) and hypoesthesia (n = 20, 28.6%) were the most common complications. There were no significant differences in the complications among the 3 reconstruction materials, MEDPOR, resorbable sheet, and bone graft ($P > 0.05$).

During follow-up of diplopia, most patients were improved by 1 year in the MEDPOR and resorbable sheet groups; there were no significant differences between these 2 groups with regard to prognosis. For patients with hypoesthesia, most improved by 6 months (93.1%) in the MEDPOR group and 3 months (90.0%) in the resorbable sheet group. The improvement of hypoesthesia in the MEDPOR group was more rapid than in the resorbable sheet group. For enophthalmos, 96.9% and 92.3% were improved 1 month after repair in the MEDPOR and resorbable sheet groups, respectively. All patients were improved by 6 months after repair in the MEDPOR group and by 1 year in the resorbable sheet group.

In conclusion, insight into the epidemiology of orbital bone fractures and associated injuries is useful not only for developing prevention strategies, but also for decisions with regard to patient care, development of optimal treatment regimens, and appropriate resource allocation. We present the demographics, mechanism of injury, and associated injuries in one of the largest series of orbital fractures reported in the literature to date. Our findings demonstrate significant differences in the demographics and clinical presentation that, if applied to patients, will enable a more accurate diagnosis and prediction of concomitant injuries and sequelae.

REFERENCES

1. Nam SB, Bae YC, Moon JS, et al. Analysis of the postoperative outcome in 405 cases of orbital fracture using 2 synthetic orbital implants. *Ann Plast Surg* 2006;56:263–267
2. Koornneef L. Current concepts on the management of orbital blow-out fractures. *Ann Plast Surg* 1982;9:185–200
3. Tong L, Bauer RJ, Buchman SR. A current 10-year retrospective survey of 199 surgically treated orbital floor fractures in a nonurban tertiary care center. *Plast Reconstr Surg* 2001;108:612–621
4. Hogg NJ, Stewart TC, Armstrong JE, et al. Epidemiology of maxillofacial injuries at trauma hospitals in Ontario, Canada, between 1992 and 1997. *J Trauma* 2000;49:425–432
5. Shere JL, Boole JR, Holtel MR, et al. An analysis of 3599 midfacial and 1141 orbital blowout fractures among 4426 United States Army Soldiers, 1980-2000. *Otolaryngol Head Neck Surg* 2004;130:164–170
6. Dutton JJ, Manson PN, Putterman AM, et al. Management of blow-out fractures of the orbital floor. *Surv Ophthalmol* 1990;35:279–298
7. Dimitroulis G, Eyre J. A 7-year review of maxillofacial trauma in a central London hospital. *Br Dent J* 1991;170:300–302
8. Lim LH, Lam LK, Moore MH, et al. Associated injuries in facial fractures: review of 839 patients. *Br J Plast Surg* 1993;46:635–638
9. Leibsohn J, Burton TC, Scott WE. Orbital floor fractures: a retrospective study. *Ann Ophthalmol* 1976;8:1057–1062
10. Converse JM, Smith B, Obear MF, et al. Orbital blowout fractures: a ten-year survey. *Plast Reconstr Surg* 1967;39:20–36
11. Hoyt DB, Davis JW, Jurkovich GJ, et al. Trauma. In: Greenfield LJ, ed. *Surgery: Scientific Principles and Practice*. 1st ed. Philadelphia, PA: Lippincott, 1993
12. Koutroupas S, Meyerhoff WL. Surgical treatment of orbital floor fractures. *Arch Otolaryngol* 1982;108:184–186
13. Fujino T. Experimental "blowout" fracture of the orbit. *Plast Reconstr Surg* 1974;54:81–82
14. Villarreal PM, Monje F, Morillo AJ, et al. Porous polyethylene implants in orbital floor reconstruction. *Plast Reconstr Surg* 2002;109:877–885
15. Antonyshyn O, Gruss JS, Galbraith DJ, et al. Complex orbital fractures: a critical analysis of immediate bone graft reconstruction. *Ann Plast Surg* 1989;22:220–233

