RESEARCH PAPER | Medicine | Volume : 4 | Issue : 11 | November 2014 | ISSN - 2249-555X

Effect of ct Navigation in Surgery of Blow-Out Fractures of the Orbital Floor on Functional and Anatomical Results

KEYWORDS: blow-out fractures, diplopia, enophthalmos,operation, CT navigation

Daniel Kovar	ZdenekVoldrich	Pavel Voska
Charles University,3rd Faculty of Medicine in Prague, Czech Republic	Charles University,3rd Faculty of Medicine in Prague, Czech Republic	Central Military Hospital, Prague, Czech Republic

Jan Lestak	Eva Drahokoupilová
Charles University, Faculty of Medicine in Hradec Králové, Czech Republic	University of Defence, Faculty of Military Health Science in Hradec Králové

ABSTRACT *The aim of work was to assess anatomical and functional results of surgically treated orbital floor fractures in relation toCT navigation surgery.In the interval of 2007 – 2013, we surgically treated 40 blow-out fractures of the orbital floor.A series was divided into two groups identical in number. The first group comprisedeight-women and 12 men. The second group comprised six women and 14 men.The first group was operated without CT navigation (7 times from subtarsal approach, 13 times from transantral approach). The second group had 7 times transantral approach and 13 times from subtarsal. Patients stated preoperative diplopia in the first group 18 times, in the second group 20 times. Diplopia was revealed after the surgery in the first group in four cases (20 %), diplopia was not revealed in the second group (0 %). Enophthalmos was identified preoperatively in all patients in both groups, and postoperatively in the first group in thre (15 %), in the second group in two patients (10 %).Computer assisted surgery showed better functional and anatomical results than surgery without CT navigation. We did not find diplopia in any operated patient with CT navigation in postoperative period. We did not notice relation of diplopia to operation approach and use of fixation materials.*

Introduction

Surgery of orbital floor fractures is significant for an ophthalmologist due to persistent postoperative diplopia which can evidently limit a quality of patient´s life. Enophthalmos and sensitivity failure in the area of the infraorbital nerve are not so significant.

The Central Military Hospital in Prague (authors´workplace) has had nearly 40 years´ experience with surgery of facial traumas [1,2,3]. Thanks to the development of new technologies, this work can follow-on to our previous results. The aim of the workis to assess anatomical and functional outcomes in surgically treated fractures of the orbital floor in relation to CT navigation surgery,approach routes and types of fixation materials.

Series of patients and methods

In the interval of 2007 to 2013, we surgically treated 40 blow-out fractures of the orbital floor rat our department. The series was divided into two groups.The first group comprised eight women (aged 16-83 years, the mean age was 53 years) and 12 men (aged 21-62 years, the mean age was 36 years) and they were treated without CT navigation. The second group comprisedsix women (aged 29-72, the mean age of 40 years) and 14 men (aged 16-64, the mean age of 32 years). This group underwent surgical intervention with use of CT navigation.

Orbital contusion at sports and after physical coercion was determined as a cause of fracture in the first group10 times,9 times contusion after a fall and once polytrauma. In the second group, 17 times it was orbital contusion at sports and after physical coercion, in three cases, the reason was polytrauma. Enophthalmos occurred preoperatively in all 40 cases. Table 1,2.

We indicated revision surgery in clinically significant enophthalmos associated with a defect of the orbit (based on CT examination) with present diplopia. Furthermore, in persistent double vision after the resolution of edemas of the orbital soft tissues, in the entrapped inferior rectus muscle confirmed with CT, in positive passive duction and even in endangered orbital contents with bone fragments. In two patients of the first group, who did not present preoperative diplopia, the operation was indicated due to the extensive defect of the orbital floor with a substantial prolapse. In postoperative period, there would be a danger of scarring of the prolapsed tissues and of diplopia development.

We have chosenthe surgical technique according to the type and location of fracture.

Long-time experience led us to the revision surgery within 14 days after the injury [2,3,4]. In four injuries of the first group, patients with persistent diplopia lasting more than 14 days found our care. In the second group, the surgical treatment was performed in three patients within the period of more than 14 days.

Using the transantral approach (13 times in the first group and 7 times in the second group), we assessed the extent of the fracture and the size of prolapsed part of the orbital contents under direct view or endoscopicallyusingantrotomy performed through the anterior wall of the maxillary sinus via the sublabial incision with the use ofendonasal optics. Subsequently, we removed mucosa from the blown-out part of the orbital floor and its appendages then we released and aligned bone fragments to the right position and fixed them with the aloplasticstrut. Discs – poly (2-hydroxyethylmethacrylate) and plates – poly (methylmethacrylate) werenecessary to remove from the maxillary

Volume : 4 | Issue : 11 | November 2014 | ISSN - 2249-555X

sinus after thre months so that unfavourable complications would not be developed in case of potential inflammatory diseases. The used strut consisted of a hydrone disc and a superacrylate plate with a steel spiral, the end of which was propped against the orbital floor [2,3,4].

The minimum observation time after the operation was 3 years.

Using the subtarsal approach (7 times in the first group, 13 times in the second group), we led an incision along the inferior edge of the lower eyelid, and after intersection of the ocular orbicular muscle, we cut the periosteum at the inferior orbital rim. Subsequently, we elevated under the eye control the contents of the orbit with the periorbit from its bottom and gradually released herniated or pinched part of the periorbit or the ocular inferior rectus from the blow-out area. The orbital floor defect was covered by implants adjusted according to the size- thethermoplasticresorbablePolyMax Rapid (PRM) and the resorbable PDSsplints.

The minimum observation time after the operation was 4 years.

Perioperative passive duction was a part of both surgeries.

We indicated the transantral approach in all orbital floor fractures when the resorbable materials were not available. Recently, we have used it in extensive devastating injuries of the orbital floor. The subciliar approach was effective in fractures with preserved firm edges which werein majority of the injured.

The essential contribution to the orbital floor traumas surgery using both approach routes is CT navigation. With CT navigation, we verified perfection of performed mobilisation and reposition of the bone fragments and subsequent right fixation of the fracture.

All patients of the second group underwent spiral CT scanning preoperatively, and CT data were imported to the Treon Plus navigation /Medtronic Company). The optic system is concerned which allows image fusion of CT and MRI.

Sex/age	Type of injury	Extent of fracture	Type of fracture	Eye position (before/ after)	Motility (before/after)	Diplopia (before/ after)	Time (days) injury/ surgery	Operation	Material
F/16	contusion	anteroposterior	II B	En/N	R/N	Y/No	7	TAB	strut
F/19	fall	posterior	II A	En/N	R/NR	Y/No	5	SUBT	PMR
M/21	contusion	anteroposterior	II B	En/N	R/R	Y/Y	11	TA	strut
M/23	contusion	posterior	II B	En/N	R/NR	Y/No	6	TA	strut
M/23	contusion	anteroposterior	II B	En/N	NR/NR	No/No	4	SUBT	PMR
M/26	fall	anteroposterior	III A	En/En	R/R	Y/Y	11	SUBT	PDS
M/27	fall	anteroposterior	II B	En/En	R/R	Y/Y	12	TA	strut
M/32	contusion	anteroposterior	III A	En/N	R/NR	Y/No	57	TA	strut
M/37	contusion	anteroposterior	III B	En/En	R/R	Y/Y	17	TA	strut
F/38	fall	anteroposterior	I A	En/N	R/NR	Y/No	47	SUBT	PMR
M/39	contusion	anteroposterior	III B	En/N	R/NR	Y/No	7	TA	strut
M/39	contusion	posterior	II B	En/N	R/NR	Y/No	10	TA	strut
M/47	fall	anterior	II B	En/N	R/NR	Y/No	6	SUBT	PDS
F/56	polytrauma	anteroposterior	II B	En/N	R/NR	Y/No	15	TA	strut
M/59	fall	anteroposterior	II B	En/N	R/NR	Y/No	4	SUBT	PMR
F/60	fall	anteroposterior	III B	En/N	R/NR	Y/No	7	TA	strut
M/62	contusion	posterior	III A	En/N	NR/NR	No/No	9	TA	strut
F/75	contusion	anteroposterior	II B	En/N	R/NR	Y/No	5	SUBT	PMR
F/77	fall	anteroposterior	II B	En/N	R/NR	Y/No	11	TA	strut
F/83	fall	posterior	III B	En/N	R/NR	Y/No	10	TA	strut

Table 1.The synoptic table of patients surgically treated without CT navigation. The fracture extent according to Kwon and associates (8). The type of fracture is divided according to Harris (7). Enophthalmos, N-normophthalmos, R-restriction, NR-no restriction, TA-transantral approach, SUBT-subtarsal approach.

Volume : 4 | Issue : 11 | November 2014 | ISSN - 2249-555X

Sex/age	Type of injury	Extent of frac ture	Type of fracture	Eye position (before/after)	Motility (before/af ter)	Diplopia (before/ after)	Time (days) injury/ surgery	Operation	Material
M/16	contusion	anteroposterior	II B	En/N	R/NR	Y/No	8	SUBT	PMR
M/18	contusion	anteroposterior	II A	En/N	R/NR	Y/No	25	TA	strut
M/20	contusion	anteroposterior	III A	En/N	R/NR	Y/No	3	TA	strut
M/21	contusion	anteroposterior	III A	En/N	R/NR	Y/No	5	SUBT	PMR
M/24	contusion	anteroposterior	II B	En/N	R/NR	Y/No	3	SUBT	PMR
M/26	contusion	anteroposterior	II B	En/N	R/NR	Y/No	2	SUBT	PMR
M/28	contusion	anterior	I B	En/N	R/NR	Y/No	15	TA	strut
F/29	contusion	anteroposterior	II B	En/N	R/NR	Y/No	5	SUBT	PMR
M/30	contusion	anteroposterior	II A	En/N	R/NR	Y/No	3	SUBT	PMR
F/30	polytrauma	posterior	II B	En/En	R/NR	Y/No	10	SUBT	PMR
M/32	contusion	anteroposterior	III B	En/N	R/NR	Y/No	18	TA	strut
M/32	contusion	anteroposterior	III B	En/N	R/NR	Y/No	7	SUBT	PMR
F/34	contusion	anteroposterior	II B	En/N	R/NR	Y/No	7	TA	strut
F/37	contusion	anteroposterior	II B	En/N	R/NR	Y/No	5	SUBT	PMR
F/38	contusion	posterior	II A	En/N	R/NR	Y/No	7	SUBT	PMR
M/43	polytrauma	anteroposterior	III B	En/En	R/NR	Y/No	7	TA	strut
M/47	contusion	anteroposterior	III A	En/N	R/NR	Y/No	7	SUBT	PMR
M/53	contusion	anteroposterior	III B	En/N	R/NR	Y/No	9	TA	strut
M/64	polytrauma	anteroposterior	III B	En/N	R/NR	Y/No	6	SUBT	PMR
F/72	contusion	posterior	II B	En/N	R/NR	Y/No	3	SUBT	PMR

Table 2. The synoptic table of patients surgically treated with CT navigation. The fracture extent according to Kwon and associates (8). The type of fracture is divided according to Harris (7). Enophthalmos, N-normophthalmos, R-restriction, NR-no restriction, TA-transantral approach, SUBT-subtarsal approach.


a


b

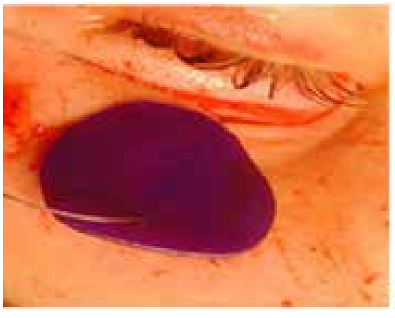
c

Fig. 1 Materials used for reconstruction.Poly(2-hydrox-

Volume : 4 | Issue : 11 | November 2014 | ISSN - 2249-555X

yethylmethacrylate) disc and poly(methylmethacrylate) plate with the strut a).PolyMaxRapid[PMR] disc –poly(L-lactid-co-glycolid) b). PDS disc – poly(p-dioxanon) c).

We used alloplasts in reconstruction surgery such as poly(2-hydroxyethylmethacrylate) disc and poly(methyl-methacrylate) plate with the strut. Both types of alloplasts underwent a long period of clinical testing. They are approved for implantation into the human organism by the State Institute for Drug Control, Czech Republic, i.e. medical grade, hence they are biocompatible. We also used PolyMaxRapid disc –poly(L-lactid-co-glycolid) and PDS disc – poly(p-dioxanon).Fig. 1.

PMR unlike PDS is resorbableslowlier and is shapable by heat. As far as the material is concerned, the use of PMR splint is more suitable due to its shaping, better stability on the orbital floor and a longer period of absorption.

Results

In the first group without CT navigation, diplopia persisted even after the operation in 4 patients (20 %). In three cases, the operation was performed from the transantralapproach and in one patient from the subtarsal approach. In three casesthe operation was performed until 14 days after injuries, in the forthcase, the operation was performed14 days after injuries. Diplopia appeared in all four patients in upper vertical visual direction over 30 degrees and did not bother the patients.

In the second group, diplopia was not noticed.

Enophthalmos, which occurred preoperatively in all patients of the first group, persisted also after the operation in three patients (15 %). In the second group consisted of 20 patients, it disappeared in 18 patients and persisted in 2 patients (10 %).

Motility disorder persisted postoperatively in all patients with diplopia. See Table 1 and 2.

In subciliar approaches, initially, exophthalmos with postoperative diplopia in marginal positions reveals to be clinically unsignificant. The release of the periorbit leads to greater traumatisation of the soft-tissues and development of edema. These symptoms subside soon and disappear completely in connection with the onset of absorption of the resorbable disc (PMR and PDS) around the 3rd upto the 6th month.

Discussion

Having long-time experience with the orbital surgery, currently, we have no problems with proper timing of a surgical intervention. Two weeks are enough for the orbital hematoma and edema to subside or reduce and to prepare a patient to operation [2,3,4]. Other surgeons also share this opinion, [5,6]. Similarly, indications to surgical intervention come out from the clinical finding and its development in time.

We cite in this connection works by Harris who recommends surgery in such orbital floor defects in which clinically significant enophthalmos is expected or in persistent and not decreasing diplopia within 14 days after the injury. He classifies fractures according to fracture lines into 3 main groups and each is subdivided into 2 subgroups (analysed on coronal CT scans) [7].

I. „Trap door" fracture – fracture edges without shift, without (a) or with (b) presence of orbital tissue (b) in the orbital cavity.

II. Bone fragments are hooked or turned slightly into the oral cavity and the soft-tissues are placed between them. The subtype (a) contains less prolapsed mass than it is the distance between the bone fragments, if the content is bigger, then thesubgroup (b) is concerned.

III. Orbital floor fractures with dislocation offragments are inverted or turned slightly into the maxillary sinus and occupied by the soft-tissues. The subtype (a) is associated with a slight shift, the subtype (b) with a significant displacement of bony fragments and the soft tissues of the orbit.

Furthermore, we presume to cite the works by Kwon and associates who classify the orbital floor fracture into anterior, posterior and anteroposterior. They recommend the transorbital or combined approach in fractures of the anterior half of the orbital floor and in trap-door fractures with the entrapped inferior rectus muscle [8]. Then the transantral or again combined approach in fractures of the posterior half of the orbital floor. Worse prognosis is revealed in children´s fractures due to more frequent entrapped muscle. If surgical intervention is indicated, then most frequently it is performed within 14 days after the injury in adults and within 5 days after the injury in children, unless the indication is urgent.

As mentioned in the introduction, the highest handicap for a patient is persistent diplopia.Literature data reveal its different percentage incidence. When we look at last years´ literature results, the incidence can range from 8,7 - 67 % [9, 10, 11, 12, 13, 14]. Chi et al. assert the least number of postoperative diplopias 8,7 % [9]. Our previous results without CT navigation revealed postoperative diplopia in 13 % [3] and they were in correlation with the results of newer works 17 % [11].

In our first group without CT navigation, diplopia persists even after operation in 4 patients (20 %).

In the second group with CT navigation, we found out not a single case of diplopia. We suppose that besides experience and the selection of operation procedure, CT navigation has principally a decisive share on these results.

We have no possibility to compare our functional results using CT navigation with any available literature data. They are only partially assessed in our previous studies [15].

Only three works by Pham and associates, Schramm and associates, Beumer and Puscas [16, 17, 18] recommend the use of CT navigation in maxillofacial skeleton fractures to minimize posttraumatic enophthalmos and to achieve better symmetry of the face. Moreover, Schramm and associates and Collyer [17, 19] emphasize its great contribution to secondary reconstruction of the orbit.

Conclusion

In surgically treated retromarginal fractures of the orbital floor, which we clinically assessed after the operation, our anatomic and functional results achieved with the use of CT navigation were better than literature data. Functional results with the use of CT navigation have not been published yet. In the group without CT navigation, the patients reported postoperative diplopia in four cases namely in the visual direction over 30 degrees.

Volume : 4 | Issue : 11 | November 2014 | ISSN - 2249-555X

CT navigation facilitated reposition and simplified reconstruction particularly in anteroposteriorfractures. However, we are aware of quite a small group of patients. Simultaneously, CT navigation enables transorbital surgical treatment of larger backwards extending fractures of the orbital floor, in which we previously had to use transantral approach.

Application of resorbable materials from subciliar approach was effective in fractures of the orbital floor with sustained firm edges. The advantage lies in one-stage procedure, and after absorption of the material, also inabsence of a foreign body. The disadvantage is a small scar at theedge of the lower eyelid.

Vast comminutedfractures of the orbital floor require the transantral or combined approach and use of the strut (two-stage operation), the titanic grate or PMR splint with or without screw fixation (one-stage surgeries). Naturally, one-stage surgeries have socioeconomic and psychological impacts.

The study protocol was approved by the local Ethics Committee and the study was performed in accordance with Good Clinical practice and the Declaration of Helsinki.

Conflict of interest statement:
The authors stated that there are no conflicts of interest regarding the publication of this article.

This study was supported by the Research programme of MO 1212 CH.

REFERENCE

1. Zelený M, Voldřich Z, Kozák J (1978)Příspěvek k rekonstrukcispodinyočnice. ČsOtolaryng 27: 122-125 | | 2. Voldřich Z, Cigánek L, Kozák J, Sobota J (1983) Chirurgickéřešenízlomeninspodinyočnicepomocípolymerníchmateriálů. ČsOtolaryng 32: 332-339 | | | 3. Cigánek L, Voldřich Z, Lešták J (1990)Diplopie u zlomeninspodinyočnice. ČsOftal 46: 139-144 | | 4. Voldřich Z (1987)Použitíněkterýchpolymerů v otolaryngologii. Doktorskádizertačnípráce, Praha | | | 5. Harris GJ (2006) Orbital blow-out fractures: surgical timing and technique. Eye 20: 1207–1212 | | 6. Kwon JH, Kim JG, Moon JH, Cho JH (2008) Clinical analysis of surgical approaches for orbital floor fractures. Arch Facial PlastSurg 10: 21-24 | | 7. Harris GJ, Garcia GH, Logani SC, Murphy ML, Sheth BP, Seth AK (1998) Orbital blow-out fractures: Correlation of preoperative computed tomography and postoperative ocular motility. Tr Am OphthSoc 46: 329-347 | | | 8. Kwon JH, Moon JH, Kwon MS, Cho JH (2005)The differences of blowout fracture of the inferior orbital wall between children and adults. Arch Otolaryngol Head Neck Surg 131: 723-727 | 9. Chi MJ, Ku M, Shin KH, Baek S (2010)An analysis of 733 surgically treated blowout fractures. Ophthalmologica 224: 167-175 | | 10. Jin HR, Lee HS, Yeon JY, Suh MW (2007) Residual diplopia after repair of pure orbital blowout fracture: the importance of extraocular muscle injury. Am J Rhinol 21: 276-280 | | | 11. Gunarajah DR, Samman N (2013)Biomaterials for repair of orbital floor blowout fractures: a systematic review. J Oral MaxillofacSurg 71: 550-70. doi: 10.1016/j.joms.2012.10.029 | | 12. Loba P, Kozakiewicz M, Nowakowska O, Omulecki W, Broniarczyk-Loba A (2012)Management of persistent diplopia after surgical repair of orbital fractures. J AAPOS 16: 548-553. doi: 10.1016/j.jaapos.2012.08.007 | | | 13. Ceylan OM, Uysal Y, Mutlu FM, Tuncer K, Altinsoy HI (2011): Management of diplopia in patients with blowout fractures. Indian J Ophthalmol 59: 461-464. doi: 10.4103/0301-4738.8631 | | 14. Hrušák D, Jambura J, Hauer L (2010)Zlomeninyspodinyočnice (Statistika). ČesStomat 110: 104-108 | | | 15. Kovář D, Voldřich Z, Fundová P, Navara M (2012)Využití CT navigace u retromarginálních (blow-out) zlomeninspodinyočnice. Otorinolaryng a Foniat 61: 190-194 | | 16. Pham AM, Rafii AA, Metzger MC, Jamali A, Strong EB (2007)Computer modeling and intraoperative navigation in maxillofacial surgery. Otolaryngol Head Neck Surg 137: 624-631 | | | 17. Schramm A, Suarez-Cunqueiro MM, Rücker M, Kokemueller H, Bormann KH, Metzger MC 4, Gellrich NC (2009) Computer-assisted therapy in orbital and mid-facial reconstructions. Int J Med Robotics Comput Assist Surg 5: 111–124 | | 18. Beumer HW, Puscas L (2009)Computer modeling and navigation in maxillofacial surgery.CurrOpinOtolaryngol Head Neck Surg 17: 270-273 | | | 19. Collyer J (2010) Stereotactic navigation in oral and maxillofacial surgery. Br J Oral MaxillofacSurg 48: 79-83 |