Conference paper

Nickel-Titanium Shape Memory Alloy in Reconstructive Osteosynthesis in Patients With Zygomatico-Orbital Complex Fractures

P.S. Petruk[1]*, Yu.A. Medvedev[1], Zhang Show Yi[1], V.A. Volkova[1]

[1] Dept. of Maxillofacial Surgery, I.M. Sechenov First Moscow State Medical University, Moscow, Russia *petruk_pavel@yahoo.com

*Corresponding author: P.S. Petruk, email: petruk_pavel@yahoo.com

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Abstract

At the Department of Maxillofacial Surgery I.M. Sechenov First Moscow State Medical University 120 patients with zygomatico-orbital complex fractures were treated during the period from 2011 to 2015. Different methods of the osteosynthesis are presented and discussed. Successful application experience of superelastic nickelid titanium mesh and porous nickelid titanium implants for the lower orbital wall reconstruction was reviewed.

1 Introduction

In recent years, the number of patients with lesions of the middle third of the facial skull continuing to increase due to road traffi accidents, fall, violence, sports Along with the growth of the facial skull injuries its structure has signifi tly changed due to the increase in combined and multiple fractures [1, 2]. There is a clear trend of increasing number of victims with injuries of the midface, in particular, zygomatico-orbital complex (ZOC) fractures. According to the literature traumatic injuries of ZOC take the second place after mandibular fractures and accounted up to 24% [3].

The main goal of the treatment in patients with craniofacial trauma is to restore the anatomical integrity and function of damaged bones with good aesthetic outcomes in the shortest possible time. Also, it is important to create optimal conditions for bone healing, to prevent infectious and inflammatory complications, which significantly extend the rehabilitation period of the victims [4, 5].

Despite improvement of the technologies and equipment modernization, ZOC fractures remains one of the urgent problem in modern cranio-maxillofacial surgery.

It includes not only the choice of the optimal method of bone fragments fixation, but also questions of lower orbital wall reconstruction. High percentage of complications, such as posttraumatic deformities of the lateral part of the midface, diplopia, enophthalmos, infraorbital nerve neuritis and others require the development of a new effective methods of osteosynthesis [6].

Application of the shape memory materials seems to be a promising treatment modality in many fields of medicine in a view of its superelasticity properties, high biochemical and biomechanical compatibility [7, 8, 9, 10].

The aim of this study is to improve the efficiency of surgical treatment in patients with ZOC fractures using NiTi fixing devices and implants.

2 Material and Methods

120 patients with ZOC fractures which meet the inclusion criteria underwent surgical treatment at the Department of maxillofacial surgery, I.M. Sechenov First Moscow State Medical University during the period from 2011 to 2015.

All patients were examined in the volume of the standard preoperative assessments, counseled by ophthalmologist and neurologist, conducted an X-ray and CT scans of the midface and brain. In all cases various degree of bone fragment displacement were observed.

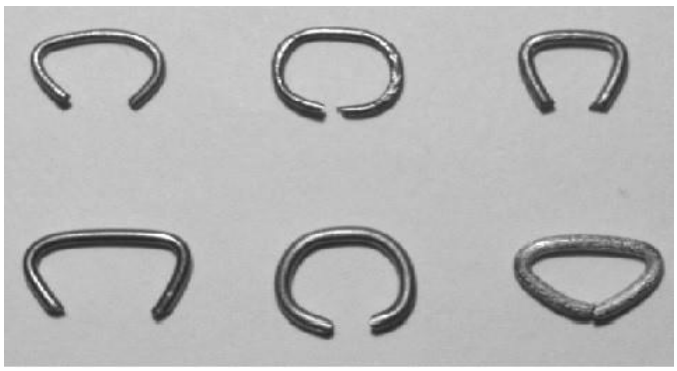

Figure 1 – U-shaped and elliptical NiTi mini clamps

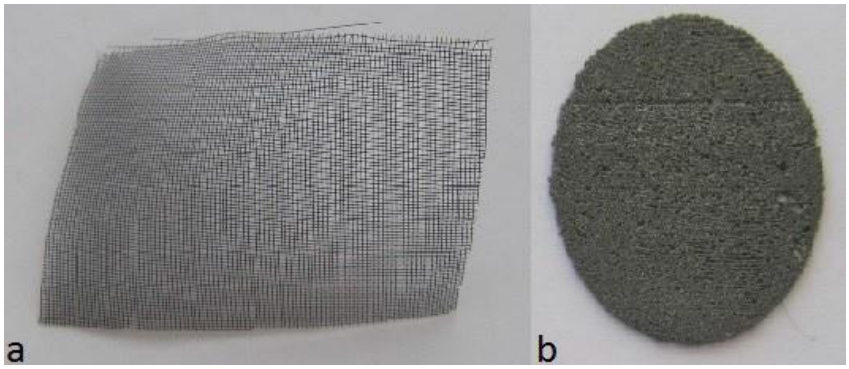

Figure 2 – NiTi implants: a – superelastic mesh; b – porous disc

Patients were divided into three treatment groups. Group A (n 40) - NiTi mini-clamps osteosynthesis. (Figure 1); Group B (n 40) - Ti plates osteosynthesis; Group C – NiTi Ti osteosynthesis.

The following parameters were compared: a) Postoperative aesthetic appearance; b) Number of fixation points; c) Duration of the surgery; d) Complications.

Rigid internal fixation was performed using U-shaped and elliptical NiTi mimi-clamps of two sizes: 1 - Ø = 0,8 мм, L = 7 мм, L1 = 4 мм, F = 14 H; 2 - Ø = 0,8 мм, L = 5 мм, L1 = 4 мм, F = 12 H. Titanium mini-plates (1.5mm) and microplates (1,2 mm) were applied in cases of comminuted ZOC fractures.

In cases of bony defect of the lower orbital wall superelastic NiTi mesh and porous NiTi disc implants were used (Figure 2).

The Foley catheter was placed in the maxillary sinus for the purpose of additional fragments fixation, as well as isolation of the implant from exposure of environmental factors.

Case 1. Patient K., 52 y.o., Ds: Left side displaced ZOC fracture. Hemosinus. Posttraumatic neuropathy of the infraorbital nerve. Brain concussion.

Volume of the surgery: ZOC open reduction and rigid internal fixation. Defect elimination of the lower orbital wall with superelastic NiTi mesh. Infraorbital nerve decompression. Maxillary sinus revision.

Under general anesthesia (oroendotracheal intubation) ipsilateral lateral brow incision was made to expose the fracture line at the frontozygomatic region. Subcilary incision was made to expose the fracture line at the infraorbital region. 8x10 mm bony defect of lower wall of the orbit was detected. Transoral vestibular incision was placed extending from canine to molar region on the involved side.

Reduced fracture was fixed at the frontozygomatic region and infraorbital rim using NiTi mini-clamps. Bony defect of lower wall of the orbit was closed with superelastic NiTi mesh implant. Foley catheter was installed in the maxillary sinus, and its output tube was passed through the oral cavity. Hemostasis was achieved. Periosteum was closed using 4,0 Vycril sutures. Skin flap was sutured using 5,0 Prolene.

In the postoperative period common antibacterial and anti-infl tory therapy were prescribed. The Foley catheter was removed on the 3rd day after surgery. Sutures were removed on the 7th day. At the time of discharge the facial symmetry was restored. After 1 year follow up complete recovery of the infraorbital nerve was noted (Figure 3).

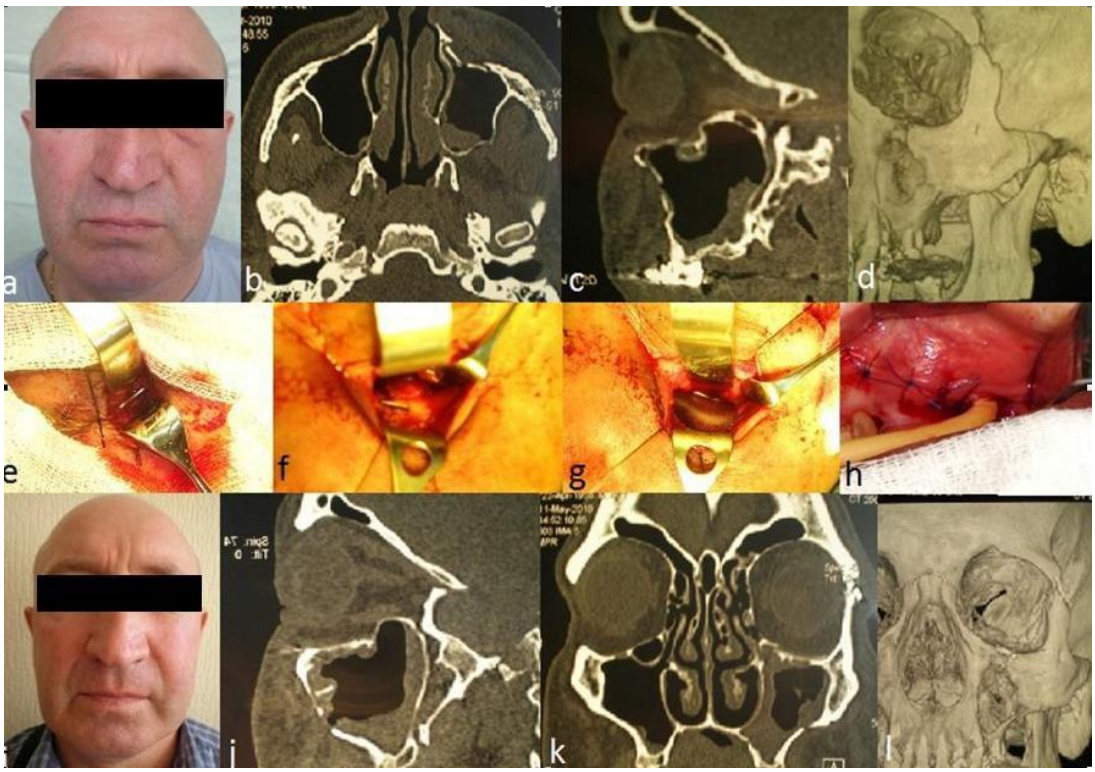

Figure 3 – Case 1: a-d – preop view; e-h – stages of surgery; i-l – postop view

3 Results

A total of 120 patients (106 men and 14 women) aged 16 to 70 years were included. Peak incidence was in 20 to 30 years age group. In most patients, 92(76.67%) the injury was received as a result of domestic violence. Preoperative and postoperative radiographs were compared. Alignment and stability of ZOC fragments were found satisfactory in all groups.

ZOC fracture was accompanied by medium and finely comminuted, more often at the area of infraorbital rim and zygomatic buttress in 57(47,5%) cases. Application of lower orbital wall reconstruction techniques required in 29(24,17%) cases; infraorbital nerve decompression – 33(27,5%). Long-term infraorbital nerve paresthesia (more

than 6 months) was noted in 11(9,17%) cases.

For the above mentioned period no postoperative complications associated with secondary bone displacement, infection, ophthalmic and other functional disorders were obtained.

4 Conclusion

We recommend the use of Ti micro- and mini-plates in cases of comminuted ZOC fractures, in cases of noncomminuted ZOC fractures – NiTi mini-clamps. Damage of the orbital floor is a natural phenomenon seen in ZOC fractures. The use of superelastic mesh and porous NiTi implants is a simple and reliable method of lower orbital wall reconstruction. Due to unique properties usage of NiTI fixing devices and implants allows to improve the effectiveness of surgical treatment in ZOC fractures with high aesthetic and functional results.

5 Acknowledgments

TiNi-based medical materials and implants (solid clamps, mesh and porous disc) were developed and manufactured at the Research Institute of Medical Materials and Implants with shape memory (Tomsk).

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