Interdisciplinary Neurosurgery 17 (2019) 72–74

Contents lists available at ScienceDirect

Interdisciplinary Neurosurgery

journal homepage: www.elsevier.com/locate/inat

Technical Notes & Surgical Techniques

Surgery of severe open cranio-orbital injury with regional tissue defect

Yan Zhao, Zhihua Chen, Wei Shi, Zhilin Guo*

Neurosurgical Department of the Ninth People's Hospital of Shanghai, Medical School, Shanghai Jiaotong University, China

Severe cranio-orbital injury with regional tissue defect is rare and usually results from falls, motor vehicle collisions, and explosions. It involves cerebral, dural, anterior cranial fossa, and eyeball tissues, and with local skin defect, cerebral tissue can run out through the wound. Its treatment includes cerebral debris removal, orbital exenteration, dural repair, and, sometimes, reconstruction of the anterior cranial fossa, and covering of the regional defect. Izquierdo et al. reported that with a free tissue flap, the anterior cranial fossa could be satisfactorily reconstructed and could prevent cerebral spinal fluid (CSF) leaks [1]. Many maxillary tumor surgeons then reported successful reconstruction of the cranial base. However, now the challenge remains to reconstruct large cranio-orbital defects of a contaminated wound in emergency surgery. Ideal intervention for the frontal sinus has been controversial: cranialization or obliteration of the sinus? [2,7]. How can the defect of the anterior cranial fossa be covered, with rib or artificial material? Which flap should be used to cover the wound, regional or free tissue flap? [3,8].

The purpose of this study was to report our experience with 15 cases of severe open cranio-orbital injury with regional tissue defects.

1. Patients and methods

From January 2008 to December 2017, 309 cases of cranio-orbital injury were treated in our department. Of these were 15 cases with severe open cranioorbital injury with regional tissue defects (according the criteria of severe craniocerebral injury). These 15 cases were retrospectively reviewed. The data reviewed included the patients' demographics, clinical, surgical data, and complications as well as follow-up results. Details of surgical debridement and reconstruction were especially reviewed, including methods of dural mending, type of free flap used, and use of lumbar drainage.

1.1. Operative technique

Debridement was aggressively performed first. The necrotic and contused cerebral tissue as well as small bone fragments was removed, and then the intraorbital tissue was debrided. In cases of large crush defects of the wall of the frontal sinus, the cranialization of the frontal sinus may then be necessary. The dural defect was mended to be watertight with fascia lata. The orbital cavity and localized skin defect was covered by transferring a flap, which included an adjacent flap and a free transferring flap. The free flap needed anastomosis of the small artery and veins.

2. Results

All 15 cases were transferred to our service within 12 h after injury. Their clinical materials were detailed in Table 1. Of 15 cases, the eyeballs of 4 cases were enucleated during injury, and 11 cases had severe eyeball injury that necessitated removal of the eyeball during debridement. Two cases had open fracture of the anterior and posterior walls of the frontal sinus, which required cranialization. From 2008 to 2009, localized flap transfer was used to cover defects after debridement, but space would remain in the intraorbital cavity. After surgery, both of these cases developed infection and a CSF leak. One case was treated with conservative therapy and lumbar drain and was cured. The other case had to be re-debrided and the remaining space filled with fatty tissue. Thirteen cases received a transferred free latissimus dorsi flap to cover the regional defect and then underwent an uneventful postoperative process. No case presented local infection or CSF leak.

2.1. Follow-up

At the 3-month follow-up, no case exhibited a CSF leak, and no other complication occurred.

2.2. Illustrative case

2.2.1. Case 2

This 21 years old man (case 2) was transported to emergency after traffic accident. He was in comatose, left eyeball was enucleated, cerebral tissue ran out through wound (see Fig. 1A). CT scan showed that left frontal and temporal cerebral contusion, and left intraorbital hematoma, left orbital roof disappearing (see Fig. 1B). After his debridement, anterior cranial base dural was mended with galea, and local skin defect was covered with local transferred flap, intraorbital residual cavity was not filled. 5 days after surgery, the patient developed wound CSF leakage, he received lumbar drainage. At seventh day after

* Corresponding author.
E-mail address: gzlysr@126.com (Z. Guo).

https://doi.org/10.1016/j.inat.2019.03.002
Received 27 December 2018; Received in revised form 22 February 2019; Accepted 15 March 2019

Table 1
Summary of demographic data and clinical characteristics of 15 cases of severe open cranioorbital injury with regional tissue defects.

Gender	M, 13; F, 2
Age	22–36 years old, median 27.8 years old
Mechanism of injury	8 cases, traffic accidents; 5 cases, falling; 2 cases, explosion
GCS at presentation	3 cases, 5; 7 cases, 6; 5cases, 7
CT scan	Bifrontal lobe contusion and intracerebral hematoma, 9 Cases; bifrontal and bitemporal lobe contusion and intracerebral hematoma, 6 cases; single eyeball was not found in CT scans of 4 cases, intraorbital tissue was not discriminated in 11 cases. 2 cases had open fracture of the anterior and posterior walls of the frontal sinus.
Surgery	After debridement, 2 cases received local flap transfer covering defects, 13 cases undertook transferred free latissimus dorsi flap to cover the regional defect.
Complication	2 cases developed postoperative local infection and CSF leak.
Follow-up and outcome	At 3 month follow up, no CSF leak and no other complication.

Fig. 1. Case 2. Male, 21 years old, traffic trauma. (A) Preoperative photo. (B) Preoperative CT scan. (C) The defect was covered with a local transferred flap.

operation, he developed intracranial infection, and then received antibiotics treatment and lumbar drainage (see Fig. 1C). At final he recovered.

2.2.2. Case 5

This 20 years old man (case 5) presented with severe open cranioorbital injury, he was in comatose (see Fig. 2A). CT scan showed right intraorbital tissue disappearing, bifrontal base contusion and traumatic subarachnoid hemorrhage (see Fig. 2B). He received debridement, contused cerebral and intraobital hematoma were removed. Anterior cranial base dural defect was repaired with fascia lata. The orbital cavity and local skin defected were covered with transferred free latissimus dorsi flap, the artery and vein of free flap were connected with superficial temporal artery and vein (see Fig. 2C). Postoperative process was uneventful (see Fig. 2D).

3. Discussion

Open cranio-orbital injury results in exposure of cerebral tissue to the outside through the wound tract, and the traumatized brain could

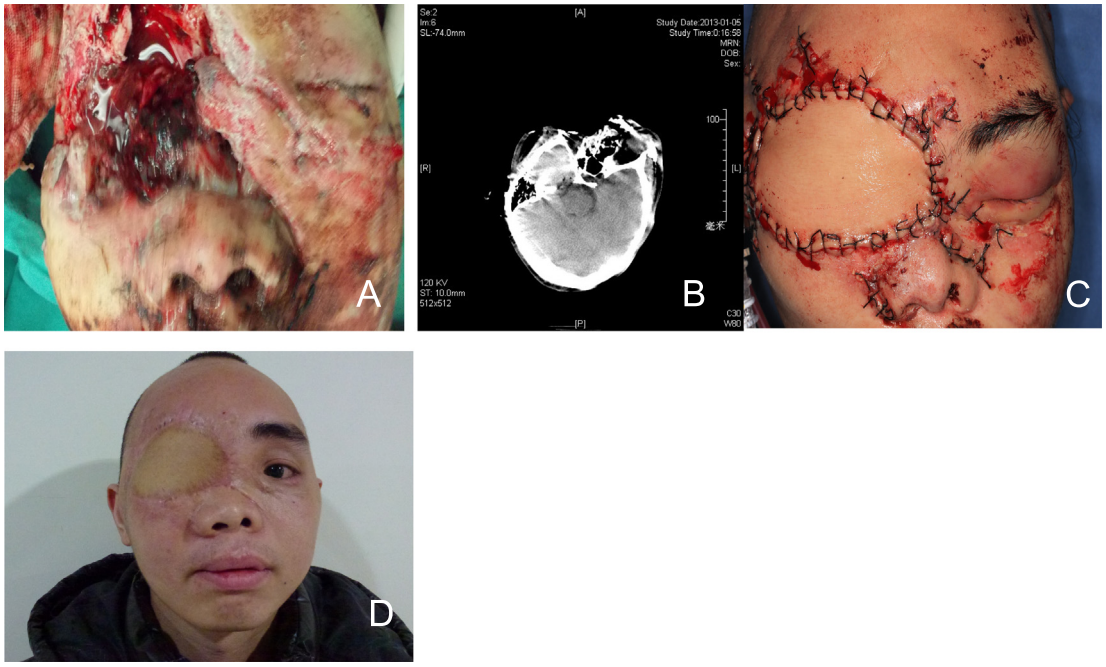

Fig. 2. Male, 20 years old, explosion trauma. (A) Preoperative photo. (B) Preoperative CT scan. (C) After microvascular transferring free flap. (D) Six months after operation.

herniate into the intraorbital cavity. The intraorbital tissue is destroyed, and local skin is lost.

Traditional treatment of open cranio-orbital trauma attempted to mend the dural defect and pack the wound or close the soft tissues temporarily. These measures would be followed by repeated conservative debridement every 2 to 3 days until the wounds were stabilized. The goal of this strategy was to preserve as much of the original tissues as possible and to repair the defect with plastic methods later. This resulted, not uncommonly, in significant contracture and fibrosis of the remaining soft-tissue structures and routinely delayed more definitive reconstructive efforts for several weeks [3].

.In the past, we attempted to cover the local defect with an adjacent flap. However, the flap was thin, and it could not pack the regional residual space. It was easy to develop a CSF leak and infection after surgery with this operative strategy. Later, we learned the microvascular free flap technique from a maxillofacial surgeon [4]. This flap is a musculocutaneous flap and could fill the intraorbital residual cavity and prevent postoperative infection and CSF leakage. With this technique, no patient developed postoperative infection, and all 13 cases achieved better cosmetic results. The microvascular free flap technique was used after ablative head–neck cancer resection, mainly to cover the soft-tissue defect treated at the beginning. In 1993, Izquierdo et al. reported that this technique could satisfactorily cover the anterior skull base defect after tumor surgery [1]. Nelign et al. detailed the methods of the free flap chosen [2]. Fechner et al. reviewed and analyzed the literature and pointed out that the free flap technique represents a significant step forward in the reconstruction of facial defects [3]. However, postoperative CSF leakage remains a great challenge. One study of 31 patients who underwent microvascular free flap reconstruction of larger anterior and middle cranial fossa defects identified a 16.1% leak rate [5]. Girod, looking specifically at latissimus dorsi free flap reconstruction of anterior skull base defects, reported CSF leak in two out of 17 cases (11.7%) [6]. These patients had undergone radiation and incomplete surgery before this surgery. Gill et al. thought that postoperative CSF leak was related to the defect location in the skull base [6]. None of the patients who received anterior cranial fossa reconstruction experienced CSF leak in their cases.

However, this study is retrospective; more cases need to be accumulated to attain valid results.

References

[1] R. Izquierdo, J.P. Leonetti, T.C. Origitano, et al., Refinements using free-tissue transfer for complex cranial base reconstruction, Plast. Reconstr. Surg. 92 (1993) 567–574 discussion 575.
[2] Neligan Pc, S. Mulholland, I. Irish, et al., Flap selection in cranial base reconstruction, Plast. Reconstr. Surg. 98 (1996) 1159–1166 discussion 1167-1168.
[3] Fechner FP, Deschler DG. Microvascular free flap reconstruction after craniofacial trauma. Operative technique in otolaryngology-head and neck surgery. 13(4):309–315.
[4] J. Vuola, J. Ohman, A.A. Makitie, Microvascular free flap reconstruction of skull base penetrating tumors, J. Reconstr. Microsurg. 27 (2011) 313–320.
[5] A. Girod, H. Boissonnet, T. Jouffroy, J. Rodriguez, Latissimus dorsi free flap reconstruction of anterior skull base defects, J. Craniomaxillofac. Surg. 40 (2012) 177–179.
[6] K.S. Gill, D. Hsu, P. Tassone, et al., Postoperative cerebrospinal fluid leak after microvascular reconstruction of craniofacial defects with orbital exenteration, Laryngoscope 127 (4) (2017) 835–841.
[7] N. Kalavrezos, Current trends in the management of frontal sinus fractures, Injury 35 (4) (2004) 340–346.
[8] T.G. Bui, R.B. Bell, E.J. Dierks, Technological advances in the treatment of facial trauma, Atlas of the Oral and Maxillofacial Surgery Clinics 20 (1) (2012) 81–94.