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Clinical outcomes for minimally invasive primary and secondary orbital reconstruction using an advanced synergistic combination of navigation and endoscopy

Chien-Tzung Chen [a,b,*], Chun-Hao Pan [a], Chih-Hao Chen [c], Victor Bong-Han Shyu [c], John Chung-Han Wu [c], Gavin Chun-Wui Kang [d]

[a] *Division of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital at Keelung, Keelung, Taiwan*
[b] *Department of Plastic and Reconstructive Surgery, Craniofacial Research Center, Chang Gung University, College of Medicine, Taoyuan, Taiwan*
[c] *Division of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital at Linkou, Linkou, Taiwan*
[d] *Department of Plastic, Reconstructive, and Aesthetic Surgery, KK Women's and Children's Hospital, Singapore*

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Summary *Background:* Sequelae of inadequate orbital reconstruction include enophthalmos, hypoglobus, and diplopia. Accuracy of orbital reconstruction is largely subjective and especially difficult to achieve because of anatomic distortion in secondary or late reconstruction and in extensive injury. We combined computer navigation and endoscopy to perform accurate, aesthetic, and safe minimal-access primary and secondary orbital reconstruction.
Methods: From 2013 to 2014, 24 patients underwent unilateral primary and secondary or late minimally invasive orbital reconstruction with mainly Medpor and/or titanium mesh by navigation and endoscopic assistance through transantral, transconjunctival, or upper blepharoplasty approaches. Mean follow-up was 13.8 months (range, 6.2 months to 2.8 years).
Results: All orbital fractures were successfully reduced. Average enophthalmos among patients who underwent early reconstruction, late reconstruction, and multiorbital wall repair improved ($p < .001$) to 0.2 mm from 1.6, 2.6, and 2.6 mm, respectively. Hypoglobus and diplopia resolved in all. In early reconstruction patients, mean interorbital volume difference improved from 1.72 ± 0.87 to 0.53 ± 0.83 ml ($P = .03$). For late reconstruction patients, this

* Corresponding author. Division of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital at Keelung, 222, Maijin Road, Keelung 20401, Taiwan.
E-mail address: ctchenap@cgmh.org.tw (C.-T. Chen).

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difference improved from 3.41 ± 1.23 to 0.56 ± 0.96 ml ($p < .001$). There were no major complications during follow-up, and all were satisfied with their final appearance and function.
Conclusion: Navigation sharpens reconstructive accuracy and avoids injury to vital structures. Combined with endoscopic assistance for minimal-access reconstruction of wide-ranging orbital defects from primary to secondary or late cases and to extensive multiwall fractures, navigation facilitates minimal cosmetic incision and synergistic endoscope use and clearly optimizes aesthetic and functional outcomes, all with enhanced safety and unparalleled intraoperative visualization.
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Introduction

Orbital fractures are common and may occur isolated or as part of a more complex facial fracture. Reconstruction is demanding, requiring thorough orbital defect assessment and accurate restoration of preinjury orbital dimensions to prevent undesired outcomes of enophthalmos, diplopia, and dystopia and achieve acceptable cosmesis.[1]

Accuracy in orbital wall reconstruction is not guaranteed using conventional surgery, and secondary surgery is often required to correct persistent deficits in appearance. Orbit reconstruction based on surgeon experience and mostly subjective assessment of adequacy equates to unpredictable results.[2,3] Accuracy is even more elusive in secondary orbital reconstruction compared with primary reconstruction, and in severe injury, because of the additional complexity of scarring and/or distorted anatomical landmarks.[4,5]

Invasive surgical incisions to expose the orbital wall defect may lead to unacceptable lower lid deformity or scalp incision comorbidity.[6] Poor visualization of intraorbital anatomy with conventional orbital access and dissection increases the risk of optic nerve injury and uncontrolled bleeding. The ideal technique should offer an accurate and safe but minimally invasive approach to orbital wall reconstruction.

Computer tomography (CT) image-guided navigation is an advanced surgical technology that offers real-time intraoperative multidimensional guidance to enhance the accuracy and safety of craniofacial reconstruction. Many attest to the increased predictability of orbital reconstruction using navigation assistance.[7]

Endoscopy has been applied to fractures of the zygomatic arch, orbit, frontal sinus, and condyle.[6,8–11] Proponents of endoscopy for orbital fractures cite the benefits of avoidance of lower lid incisions, minimal access, maximum and safe visualization of target and critical structures, and equally accurate reconstruction and stable fixation compared to conventional technique.

We introduce a novel approach to precise, aesthetic, safe, and minimally invasive reconstruction of various orbital defects using a combination of navigation and endoscopic techniques.

Patients and methods

The senior surgeon performed minimal-access primary or secondary orbital reconstruction using a combined navigation-assisted and endoscopic technique in this retrospective study from 2013 to 2014. There were 24 consecutive cases: 14 men and 10 women with a mean age of 39.3 years (range, 17–78 years). The mean follow-up was 13.8 months (range, 6.2 months to 2.8 years). Causes of injury were motor vehicle accidents in 15, falling from height in 6, assault in 2, and sports injury in 1. Indications for orbital wall repair were enophthalmos of 2 mm or more at presentation, symptomatic diplopia with positive forced duction and CT evidence of muscle entrapment, and large orbital defect ($\geq$2 cm^3 or $\geq$50% of the floor for floor defects).

Early surgery—defined as definitive orbital surgery done within 30 days of injury—was performed for eight patients (Table 1) with an average lag of 13.1 days (range, 2–30 days).

Sixteen (66.7%) had late delayed surgery (more than 30 days after injury), with an average lag of 2.2 years (range, 1.9 months to 18.4 years). The main reason for the lengthy interval was delay in seeking treatment. Fourteen of the aforementioned 16 had undergone previous unsatisfactory primary orbital reconstruction and this time needed secondary surgery.

Four (one late case) had reconstruction of only the medial wall. Twenty required orbital floor reconstruction,

Table 1 Timing of orbital repair and presence of enophthalmos, diplopia, and hypoglobus.

Timing of orbital repair	No.	No. with preoperative enophthalmos		No. with postoperative enophthalmos			No. with preoperative diplopia	No. with postoperative diplopia	No. with preoperative hypoglobus	No. with postoperative hypoglobus
		$\geq$2 mm	<2 mm	>1 mm	1 mm	0.5 mm				
Early	8	1	4	0	1	0	3	0	0	0
Late	16	12	4	0	1	2	10	0	7	0
Total	24	13	8	0	2	2	13	0	7	0

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