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Functional and Aesthetic Restoration of Medial Canthal Region Following Naso-Orbito-Ethmoidal (NOE) Traumatic Telecanthus

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ABSTRACT

Background: Injuries to the naso-orbito-ethmoidal (NOE) complex involve functional and aesthetic aspects. The close anatomical relationship among the medial canthus, eyelids, and nasolacrimal drainage system presents a challenge to the reconstructive surgeon in treatment of post NOE traumatic telecanthus. Correction of the deformity requires adequate dissection and mobilization of the medial canthal tendon, subperiosteal exposure of the medial orbit, precise identification of the correct anatomical location for tendon placement, and secure fixation of the tendon to bone. Many techniques were described to reconstruct the medial canthal ligament and repair of telecanthus deformity.

Patients: The study included 13 patients (11 males and 2 females) who have had Telecanthus following a variable periods of NOE fracture.

Methods: The technique of medial canthoplasty consisted of reattachment of the anterior and posterior limbs of the medial canthal tendon by 2 separate wires. The two wires wee passed through a single transnasal hole drilled superior and posterior to the lacrimal fossa and secured at the contralateral side over a 6-holes titanium mesh.

Results: Over a period of 2-years, and with an average follow-up period of 12 months, the authors reported good functional and aesthetic results based on the measurement of pre- and postoperative intercanthal distance.

Conclusion: (1) Drilling one hole instead of two prevents weakening of the bone segments, (2) Twisting the wires on metal plates instead of the bone results in a more secure fixation, and (3) Proper anatomical reposition of the medial canthal tendon superior and posterior to the anterior lacrimal crest results in restoration of functional and aesthetic properties of the medial canthal region.

INTRODUCTION

The medial canthal tendon is a complex anatomical structure arising from the medial margin of the upper and lower tarsi and the orbicularis oculi. It inserts in a tripartite fashion into the region of the lacrimal crests at the medial orbit **[1]**. The normal bony insertion of the medial canthal tendon may be disrupted after trauma. Failure to reattach the medial canthal tendon results in medial canthal dystopia **[2]**.

Injuries to the nasoorbitoethmoidal complex involve functional and aesthetic aspects **[3]**. The close anatomical relationship among the medial canthus, eyelids, and nasolacrimal drainage system presents a challenge to the reconstructive surgeon. Medial canthal injuries can be broadly divided into two categories: Degloving injuries and injuries associated with bony disruption (nasoethmoidal fractures) **[4]**. Although nasoethmoidal fractures may also have a degloving component, reduction and fixation of bony fragments should occur before soft-tissue reconstruction. Soft-tissue degloving injuries, by definition, do not include bony disruption. They result from shearing forces and avulsion of soft tissue along the medial canthus, typically transmitted from the brow or forehead across the medial canthus to the lower eyelid/cheek complex **[5,6]**.

Correction of the deformity requires adequate dissection and mobilization of the medial canthal tendon, subperiosteal exposure of the medial orbit, precise identification of the correct anatomical location for tendon placement, and secure fixation of the tendon to bone. Multiple techniques have been described **[9-15]**. Transnasal wiring **[9-11]** is the most commonly used technique in most centers, but the procedure is technically difficult. It necessitates wide exposure sufficient to allow transverse passage of a wire through a bony fenestration deep within the orbit, and entails dissection of the contralateral orbit. Other techniques are ipsilateral techniques and include the nylon anchor **[12]** the stainless steel screw **[13]**, the cantilevered miniplate **[14,15]**, and the Mitek mini-GII anchor **[16]**.

In this study, the authors restore the anterior and posterior limbs of the medial canthal tendon using a single hole transnasal wiring fixed along a contralateral 6-holes titanium mesh. Furthermore, drilling was performed posterosuperior to the lacrimal crest to ensure the proper reattachment of the medial canthal tendon into its original insertion and restoration of the normal shape and function.

PATIENTS AND METHODS

The study included 13 patients (11 males and 2 females) who had been presented at the Department of Plastic Surgery, Ain Shams University, Cairo, Egypt, over a period of 2 years with post NOE traumatic telecanthus. The age of patients at the time of presentation ranged from 11 to 39 years with a mean age of 23.5 years. The cause of injury included motor vehicle accident (5 patients), bicycle accident (3 patients), and interpersonal violence (5 patients). The average duration from the onset of injury to the clinical presentation ranged from 8 months to 4.5 years with an average of 3.2 years. All patients had surgical intervention following trauma in the form of open reduction and internal fixation. The period of follow-up ranged from 6 to 12 months with an average of 9 months.

Clinical picture at time of presentation included (1) a vertically or obliquely oriented scar extending from the forehead and crossing the eyebrow, medial canthus and cheek area, (2) naso-orbito-ethmoidal fracture with bony displacement, (3) telecanthus, and (4) eyelid ptosis with or without lacrimal system injury. Radiological studies included pre- and postoperative Coronal and axial CT scan and three dimensional axial tomography.

All patients underwent clinical examination for telecanthus, including the distance (in millimeters) between the facial midline and the medial canthus which was compared with the same measurement on the contralateral uninvolved side. Examination also included canthal position, eye movement, levator function, and patency of nasolacrimal system. Standard preoperative and postoperative photographs were reviewed (Table 1).

Table (1): Patients' characteristics and clinical pictures.

Patient	Age (yr) and sex	Side	Clinical picture
1	24 male	Left	Telecanthus and old NOE fracture orbital floor fracture, enophthalmos, and lower lid ectropion.
2	31 male	Right	Telecanthus and old NOE fracture with displaced lateral nasal bone.
3	21 male	Left	Telecanthus and old NOE fracture with crooked nose.
4	15 male	Left	Telecanthus, old NOE and zygomaticomaxillary complex fracture, ptosis and dystopia.
5	27 male	Bilateral	Telecanthus (bilateral) after bilateral NOE fracture type (III) and right canalicular injury.
6	39 male	Right	Telecanthus, old NOE, ptosis and right frontozygomatic fracture.
7	29 female	Left	Telecanthus, old NOE with crooked nose and scar on the dorsum of the nose.
8	26 male	Left	Telecanthus, old NOE, orbital floor fracture, lower lid ectropion and lagophthalmos.
9	19 male	Right	Telecanthus, old NOE fracture, and orbital floor fracture.
10	18 male	Right	Telecanthus, old NOE fracture, deviated nose, canalicular injury and lagophthamos.
11	11 female	Bilateral	Telecanthus, old NOE fracture, fracture of orbital floor, right enophthalmos, and right lower lid ectropion.
12	20 male	Right	Telecanthus, old NOE fracture with orbital rim and orbital wall fractures.
13	27 male	Left	Telecanthus, old NOE fracture, ptosis and enophthalmos.

Surgical technique:

All patients were operated upon while under general anesthesia with oral endtracheal tube. One gram third generation cephalosporin was given at the induction of anesthesia.

The existed scar was removed by simple elliptical excision, then dissecting the underlying soft tissue of the medial canthal region to reach the lateral nasal bones, medial orbital wall, and medial part of the orbital rim and floor. Lower eyelid and

upper buccal sulcus incision were used to repair the old NOE fracture. A lower eyelid incision is used to expose the inferior orbital rim fractures and explore the internal orbit. The upper buccal sulcus incision was used to reduce and stabilize fractures of the nasomaxillary buttress and piriform. In 11 cases, there was an old displaced fracture of lateral nasal bone along with displaced fracture of the nasal process of frontal bone and/or frontal process of maxilla. In 9 cases, the medial canthal tendon was completely avulsed and displaced without any attached bone fragment.

One of the objectives of old nasoorbitoethmoidal fracture treatment is to restore normal orbital volume and shape in order to maintain globe position and function. The internal orbit was routinely explored if missing defects were identified on the CT scan. Defects of the orbital floor were reconstructed with titanium mesh while displaced fractures of inferior orbital rim were reduced through the lower eyelid incision and fixed with orbital plate. The authors could custom the titanium plate to fit and reconstruct each individual orbital floor defect with no any reported infections or extrusions.

Medial canthoplasty:

In all unilateral cases, the disrupted medial canthus from its bony insertion, and a vertically or obliquely oriented scar extending from the forehead and traversing the medial canthal region were constant findings. Exposure was done through the existing scar while breaking it at the medial canthus during closure. A curved vertical incision was made a few mm in front of the medial canthus of the uninjured side. In bilateral cases, a coronal approach was used instead. Dissection of the medial orbital wall was carried out in a subperiosteal plane. It was confined to a limited area in the anterior one third of the uninjured medial orbital wall enough to accommodate a mesh plate. A single hole was drilled posterior and superior to the lacrimal crest. This hole was widened at the injured side to accommodate the bulkiness of the canthal tendon and sutures at the time of tightening and to allow for overcorrection. The owl was passed from the uninjured side to reach the contralateral posterior and superior aspect of the lacrimal crest while protecting the globe with a malleable (Fig. 1A). Both superficial and deep leaflets of the medial canthal tendons were grabbed separately with wire sutures, passed transnasally with the aid of the owl to the uninjured side, and fixed over a mesh plate (Figs. 1B,2). In children, non-absorbable sutures were used instead. Dacrocystorhinostomy was performed when indicated. Subcutaneous closure of the wounds was done prior to tightening of the wires and resuspension of the medial canthal tendon. A tie-over bolster dressing was applied over the medial canthal region for a few days to minimize postoperative edema at the medial canthal region. This method is intended to easily pass a pair of bent wire strings transnasally through one drill hole and to securely fix them over a reduced titanium mesh.

RESULTS

The results of a total of 13 patients were studied (Figs. 3-6). With an average follow-up period of 9 months, restoration of the medial canthal tendon was achieved in all patients. Pre- and 6 months postoperative measurements of the canthal-midline distance in comparison to the measurement of the contralateral uninvolved side are shown in Table (2).

Most of the patients had fractures extended beyond the NOE complex, including 5 patients with orbital floor and rim fractures treated by bone graft in 2 patients while titanium mesh was applied in 3 patients. Displaced fracture of lateral nasal bones in 4 patients (2 patients had crooked nose) and they were treated by open reduction and rigid internal fixation. Reduction and rigid fixation was performed to a patient with frontozygomatic fracture and another patient with zygomaticomaxillary buttress fracture.

Probing and irrigation with stent placement was performed on 2 patients with canalicular injury which resulted in resolving the tearing problem, and Dacrocystorhinostmy was performed to another 2 patients. Eyelid Ptosis was reported in 2 patients with poor preoperative levator function. Levator advancement was performed with marked improvement of levator function at 6 months postoperatively.

Reconstruction of the orbital floor with restoration of the orbital volume greatly repositioned the globe with resolving the appearance of enophthalmos in 3 patients (Fig. 6A,B).

Statistics:

Analysis of the mean values between variables and study of the paired *t*-test revealed that the difference between the postoperative mean value of midline-canthal distance (15.53±SD 3mm) compared with the preoperative mean value of midline canthal distance (19.03±SD 3mm) was statistically significant ($p<0.05$). Meanwhile, the difference between the mean postoperative distance and the midline-canthal distance at the uninvolved side was not statistically significant ($p>0.05$).

Table (2): The pre- and postoperative measurements of midline to canthal distance (in mm) and compared to the distance of the uninvolved side.

Patients	Side	Preoperative	Postoperative	Uninvolved side
		Midline to canthal distance "in mm"	Midline to canthal distance "in mm"	Midline to canthal distance "in mm"
1	Left	17	15.5	15.5
2	Right	17.5	16	15.5
3	Left	19	16.5	16.5
4	Left	18.5	14.5	14.5
5	Bilateral	Rt. 17.5	Rt. 15.5	–
		Lt. 16.5	Lt. 15.5	
6	Right	21.5	15.5	15.5
7	Left	21	16	16
8	Left	20	15.5	15
9	Right	19.5	15.5	15.5
10	Right	18	15.5	15
	Bilateral	Rt. 19.5	Rt. 14.5	–
11		Lt. 18.5	Lt. 14.5	16
12	Right	20.5	16.5	16
13	Left	21	16	
Mean		19.03±3 SD	15.53±3 SD	15.23±3 SD

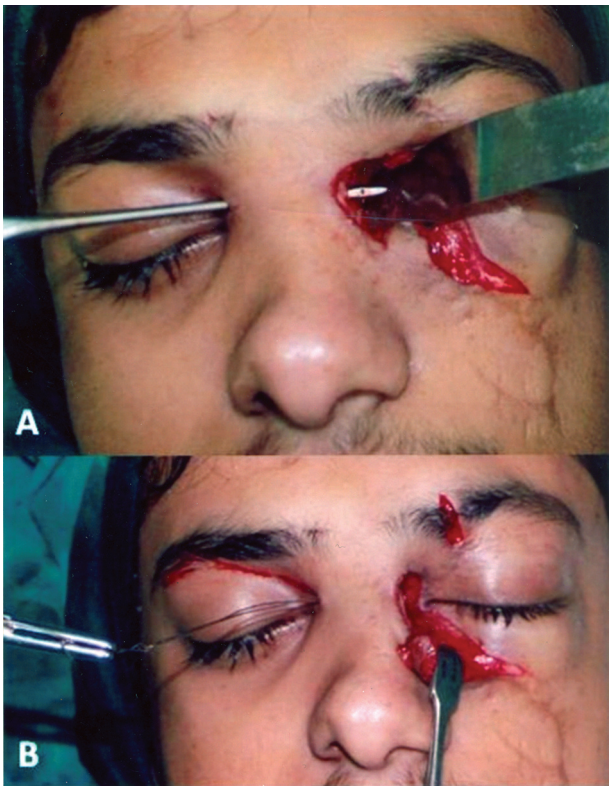

Fig. (1): Technique of transnasal wiring: A. The owl being passed from the other side posterosuperior to the lacrimal crest while protecting the globe with a malleable. B. The medial canthal tendon is found, grabbed with a wire suture and passed to the other side. DCR was also performed (white tube in the depth of field).

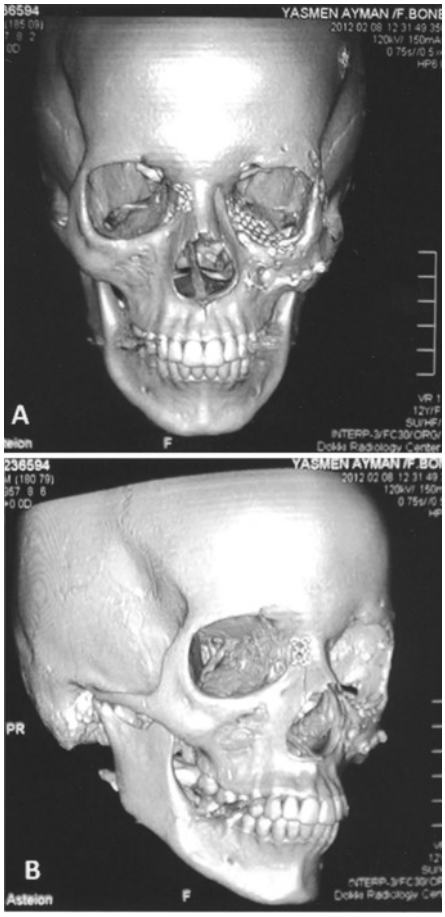

Fig. (2): Front and oblique views of 3D computed tomographic scan show the titanium plate applied anterior to lacrimal crest of the contralateral side to hold the paired wires holding the anterior and posterior limbs of the medial canthal tendon. The ends of the two wires were twisted and secured into a 6 holes titanium mesh.

Fig. (3): A. 24-year-old male with old left NOE fracture and telecanthus. B. 1 year post reconstruction.

Fig. (4): A. 21-year-old male (shown in Fig. 1) with old left NOE fracture & telecanthus. B. One month post-operative result.

Fig. (5): A. 15-year-old male with telecanthus, ptosis & dystopia that resulted from an old left NOE fracture and zygomaticomaxillary complex fracture. B. 18 months post refracture and fixation, unilateral medial canthopexy, DCR and scar revision.

Fig. (6): A. 27-year-old male with bilateral NOE fracture type (III) and telecanthus following a blow to the central midface region. B. 6 months following ORIF, split calvarial bone grafts, and transnasal canthopexy restoring his pre-accident shape. C. D- Lateral views of the same patient demonstrating the backward displacement of the nasal root.

DISCUSSION

Functional and Aesthetic deformity that results from inadequate naso-orbito-ethmoidal fracture treatment is well described by Clair et al. **[17]** and Converse and Smith **[9]**. Secondary management of NOE injuries were managed by open techniques that addressed the medial canthal tendon, orbital, and nasal bone malposition and lacrimal obstruction **[18-20]**. The evolution improving the results was open reduction interfragmental wiring which was first utilized in compound fractures but was later extended to closed injuries by Dingman and Natvig **[21]**, Dingman et al. **[22]**, and Stranc **[11]**.

Transnasal reduction of the canthal tendon bearing bone fragment is the most important step in restoring the intercanthal distance. Lateral displacement of the frontal process of the maxilla is frequently responsible for the increased intercanthal distance especially if when transnasal wiring is performed anterior to the canthal insertion resulting in telecanthus **[9,10]**. The intercanthal distance is properly preserved by performing the transnasal reduction of the medial orbital rims through drill holes placed posterior and superior to the lacrimal fossa **[9,10,23]**. In this series, treatment of telecanthus and medial canthoplasty was a secondary procedure after a period of NOE fracture. The proper management did not only depend on the repositioning of the medial canthal tendon into its anatomical insertion, but also depended on the reduction of the displaced frontal process of maxilla, medial orbital wall, and reconstruction of the orbital rim and floor.

The pitfall of the standard technique of transnasal wiring is the double drilling through the lacrimal and nasal bones which may subject the bones for further fragmentation and subsequent displacement and relapse of the telecanthus **[9-11]**. In the present study, single hole was performed, the two wires holding the anterior and posterior limbs of the medial canthal tendon was passed though it and secured on a titanium plate fixed on the contralateral medial orbital rim.

In conclusion, the main advantages of the described method may be summarized as follows: (1): One hole is drilled instead of two, greatly facilitates the operation; (2) The folded wires are passed easily through a plastic tube that is placed transnasally during drilling; (3) Drilling one hole instead of two prevents weakening of the bone segments; and (4) Twisting the wires on metal plates instead of the bone results in a more secure fixation.

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