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Technology

Increased Reliability in Medial Canthal Tendon Reposition in Nasoorbitoethmoidal Fractures with Computer-assisted Surgery and Surgical Navigation

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Summary: Avulsion of the medial canthal tendon secondary to nasoorbitoethmoidal fractures leads to severe aesthetic and functional impairments. The tendon should be repositioned at the posterior lacrimal crest. Owing to the complexity of nasoorbitoethmoidal fractures, accurate location of this point during surgery can be challenging. With the aid of computer-assisted planning and surgical navigation, the point at which the medial canthal tendon should be repositioned can be easily and precisely located. We have developed an innovative navigation-assisted technique that increases the reliability and safety of internal canthus repositioning. We performed a case series of three consecutive patients who underwent medial canthal tendon repositioning using computer-assisted planning and surgical navigation. We believe that this innovation provides a new and useful application of computer-assisted planning and surgical navigation in craniomaxillofacial surgery.
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INTRODUCTION

The medial canthal tendon supports the medial canthus, enables proper apposition between the eyelid and globe, and helps tear drainage.[1]

The posterior limb of the canthal tendon attaches to the posterior lacrimal crest. Nasoorbitoethmoidal (NOE) fractures are commonly classified according to Markowitz into three groups, depending on the comminution of bone fragments.[2] In type I fractures, there is a single large NOE fragment bearing the medial canthal tendon. In type II fractures, the NOE area is comminuted, but the medial canthal tendon remains attached to a bone fragment. Type III fractures often involve comminution of the NOE area and detachment of the medial canthal tendon from the bone. This displacement leads to an increased intercanthal distance, shortening of the palpebral aperture width, rounding of the medial palpebral angle, and an absent naso-orbital valley.

Surgery is intended to restore the NOE frame and the medial canthal area to their natural appearance by repositioning bone fragments and reinserting the medial canthal tendon in its correct position.

In NOE fracture types II and III, where the posterior lacrimal crest has been displaced or may have disappeared, assessing the lacrimal crest's previous location becomes challenging. The virtual surgical plan (computer-assisted surgery) was developed on a computer. Surgical navigation allows the surgeon to transfer this plan to the operating room by correlating the patient's anatomy with the preoperative CT data, thus allowing the surgeon to precisely locate any bony anatomical structure.[3]

The aim of this technical note is to show how computer-assisted surgery and surgical navigation help to identify and check the correct position of the displaced/destroyed posterior lacrimal crest to properly reattach the medial canthal tendon.

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TECHNIQUE

We performed a case series of three consecutive patients who underwent medial canthal tendon repositioning using computer-assisted planning and surgical navigation (Table 1). Data from a preoperative CT helical scan with 0.8-mm-thin slices were imported into the Brainlab planning software. The healthy side was superimposed on the injured side using the "mirroring" tool. The mirrored posterior lacrimal crest was marked.

A Brainlab navigator was used. The NOE frame fracture repair was accomplished; then, a cantilevered "arched" or "L" shape miniplate was modeled to the frontal bone and to the new medial orbital wall. The position of the plate was adapted until the distal hole was positioned where the plan determined that the medial canthal tendon should be repositioned (slightly posterior and superior to the posterior lacrimal crest) (Fig. 1). The distal hole of the plate was navigated (Fig. 2). The plate was provisionally fully screwed in position to the frontal bone with three or four screws and then removed.

A 2-0 metal wire with a curved needle was attached to the ligament using a double stitch. The medial canthal ligament is addressed through the coronal approach through an incision in the skin 3 mm medial to the inner canthus or transcaruncularly. The suture/wire was easily passed through the distal hole of the plate and knotted; the medial canthal tendon was attached to this distal hole of the plate. At this moment, the plate is not screwed to the bone, so it is easy to knot the wire attached to the ligament. The miniplate was then rescrewed to the frontal bone in the previously determined position, and the distal hole of the miniplate brought the medial canthal tendon to its correct position. Navigation was used again to recheck the accurate position of the medial canthal tendon. Figures 3 and 4 show the preoperative and late images of the patient´s face. (**See Video [online]**, which displays medial canthal tendon repositioning using computer-assisted planning and surgical navigation).

DISCUSSION

The normal shape and position of the medial canthus are essential aesthetic and functional features of the eye. The tendon supports the canthus, enables proper apposition between the eyelid and globe, and acts as a lacrimal pump.[1] The medial canthal tendon acts as a pivot for the soft tissue in the NOE area.

Takeaways

Question: Are computer-assisted surgery and surgical navigation for medial canthal tendon repositioning in nasoorbitoethmoidal fractures useful tools to improve the precision of reconstruction?

Findings: Virtual planning and surgery determined the correct position of the medial canthal tendon. During surgery, navigation allowed for precise repositioning of the medial canthal tendon.

Meaning: Computer-assisted surgery and surgical navigation are useful tools for guiding surgery during the repositioning of the medial canthal tendon. Computer-assisted surgery and surgical navigation reduce uncertainly and increase the precision of the reconstruction.

Suboptimal initial management of the NOE complex results in poor results, which are very difficult to restore secondarily.[4] The medial canthal tendon was reduced medially and posteriorly along the posterior lacrimal crest. Simply pulling the right and left canthi toward one another will reduce telecanthus, but an additional posterior vector reduction is needed.[5]

The key to an optimal cosmetic result is to secure the medial canthal tendon in the correct position. The position where the reconstructed canthus will be placed is a subjective decision of the surgeon. Flipping the coronal flap back and forth between the surgical sites while measuring the intercanthal distance ensures an adequate correction of the traumatic telecanthus;[6] however, it does not address the depth issue or the height of the canthus.

Computer-assisted surgery provides a highly reliable tool, especially where anatomical landmarks are missing.[7] Intraoperative navigation offers visualization of bony landmarks via comparison with virtual planning, thus allowing us to accurately locate the place where the posterior lacrimal crest should be.[8] By mirroring the unaffected orbit, the posterior lacrimal crest of the affected orbit is located.[9] Surgical navigation will allow us to reliably reposition the medial canthus.

The time to plan a trauma patient ranges between 15 and 35 minutes. The time added to the total planning time by the virtual planning of the medial canthopexy is 10 minutes.

Navigation adds 20 minutes to the operating time. But, the use of the navigation systems saves overall surgical

Table 1. Detailed Information and Characteristics of the Patients Treated with This Innovative Technique (Virtual Planning and Surgical Navigation of the Medial Canthal Tendon)

Patient	Age	Gender	Primary/ Sequelae	NOE Type	Intercantal Distance Preoperatively (mm)	Intercantal Distance Postoperatively (mm)	Virtual Planning and Surgical Navigation
1	72	Male	Primary	III	47	34	++
2	29	Male	Sequela	III	40	33	++
3	20	Male	Sequela	III	38	34	++

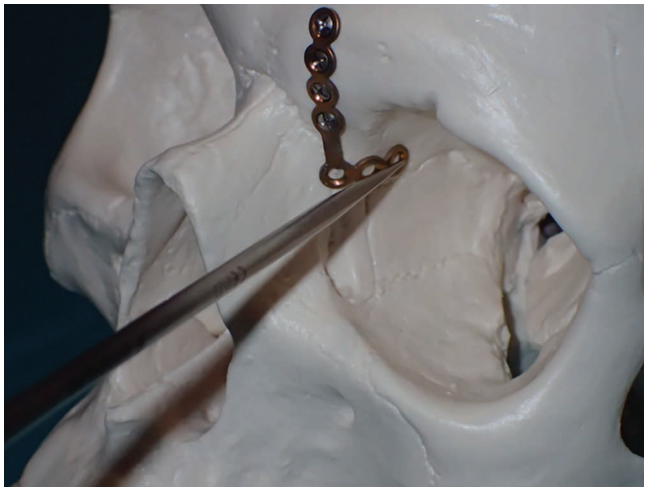

Fig. 1. An "L-shaped" or "curved" miniplate is modeled so that the long arm of the miniplate gets adapted to the frontal bone, and the short arm is adapted to the new medial orbital wall.

time because it decreases uncertainty and increases the surgeon's confidence.

The disadvantage of surgical navigation is the initial cost of this technology. However, we use it for numerous applications: tumors, microsurgical reconstruction, trauma, temporomandibular joint pathology, craniofacial deformities, orthognathic surgery, and skull base surgery.

Reported incidence of telecanthus and canthal malposition varies according to series between 6% and 15% of operated NOE fractures.[10] Probably, future longer series using the innovation described in this article will improve these reported results.

CONCLUSIONS

Virtual planning and surgical navigation may play a major role in reliably repositioning the medial canthal ligament three-dimensionally. Surgical navigation is a helpful tool to reduce uncertainty during surgery for the repositioning of the medial canthal tendon.

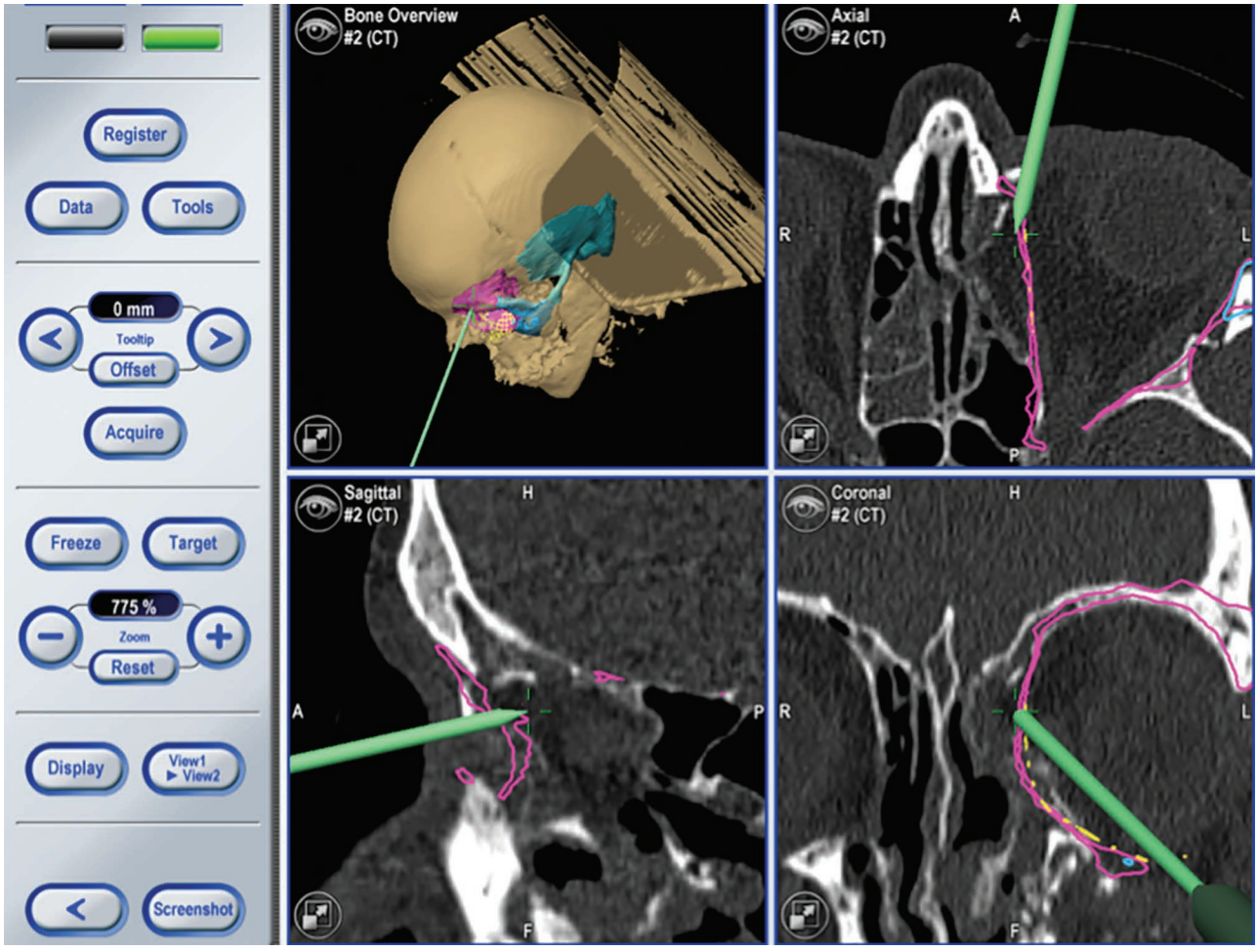

Fig. 2. The distal hole of this short arm is navigated and positioned where the preoperative plan has determined that the medial canthal tendon should be repositioned.

Fig. 3. Preoperative appearance of the patient.

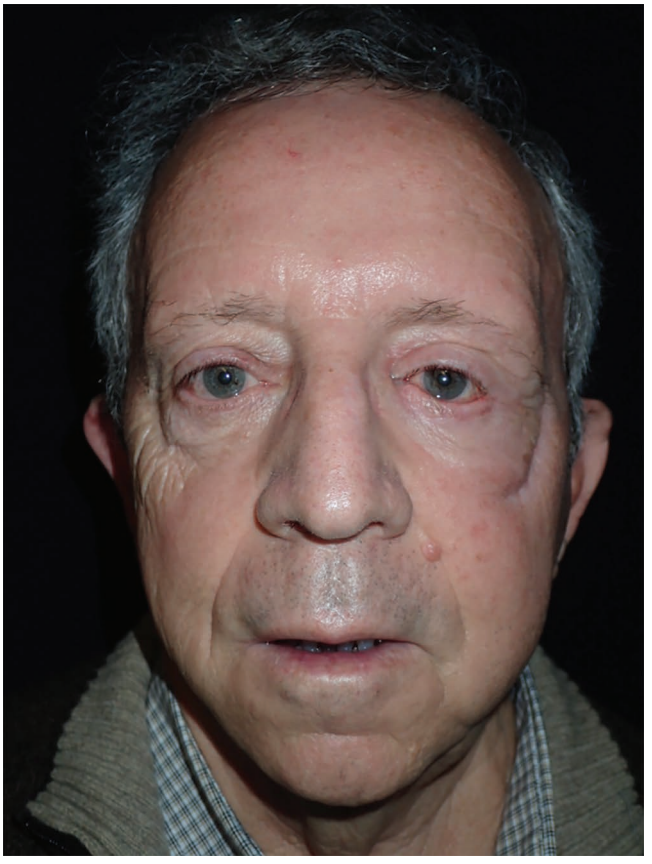

Fig. 4. Final aspect of the patient's face.

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DISCLOSURES

Dr. Dean has been a speaker in Webinar format on navigation systems. The other authors have no financial interest to declare.

PATIENT CONSENT

The patients provided written consent for the use of their images.

STATEMENT OF CONFORMITY

The study was conducted in accordance with the tenets of the WMA Declaration of Helsinki in the context of Ethical Principles for Medical Research Involving Human Subjects and was approved by the local institutional review board of our institution (Act. number 300, ref. 4538).

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