Surgical Anatomy of the Orbit in Human Cadavers—An Endoscopic Pictorial Documentation

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Abstract

Background The aim of our study was a pictorial documentation of the anatomical structures of the orbit.

Methods We performed a transmaxillary endoscopic approach in nine formalin-fixed human heads. We identified and documented the anatomy of the inferior part of the orbit.

Results The first intraorbital anatomical landmark was the inferior rectus muscle, from which important structures medially and laterally could be identified. Anatomical structures and their relation to each other were documented and presented as illustrative figures.

Conclusion Knowledge of the topographic anatomy of the inferior part of the orbit could be sufficiently imparted by our illustrations. The presented transmaxillary approach allowed a wide overview of the anatomical structures located in the inferior part of the orbit. Our pictorial documentation may provide neurosurgeons more safety and the opportunity to become familiar with the endoscopic anatomy.

Keywords

- ▶ orbit
- ▶ endoscopic anatomy
- ▶ neuroanatomy
- ▶ maxillary sinus

Introduction

Minimally invasive endoscopic approaches in neurosurgery have gained significance in the past years and have become an important part of the neurosurgical armamentarium. However, anatomical structures and their relation to each other might appear different compared with the microscopic view. Hence, it is important to provide the nonpracticed and inexperienced eye a better understanding of endoscopic anatomy. Concerning the surgical procedures of lesions in the orbit, several studies evaluated the application of endoscopy or endoscopy-assisted surgery.^{1–14} The aim of our study was the stepwise pictorial

documentation of the anatomical structures of the inferior part of the orbit from the transmaxillary endoscopic view.

Methods

This study was approved by the Ethics Committee of the Ruhr University Bochum. Nine human heads (18 orbits) fixed in formalin were prepared for examination. The veins and arteries were injected with blue and red plastic, respectively, in six cadaveric heads. The cadaveric heads were fixed straight in a Mayfield clamp, and the endoscope (Hopkins II neuroendoscope, 0 and 30 degrees optical angles; Karl STORZ GmbH & Co. KG, Tuttlingen) was placed to both orbits via the transmaxillary approach (▶ Fig. 1).

* The first and second author contributed equally to this study.

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Fig. 1 Schematic view of the transmaxillary approach. The course of the optic nerve is displayed yellow.

The surgical procedure and technique itself has been explained in detail in our previous publication.¹⁴ To demonstrate the anatomical structures, the fat tissue was removed. The anatomical structures were identified, measured, and documented.

Results

At the beginning, the front or facial wall of the maxillary sinus was visible (►Fig. 2A). The wall was perforated in the area of the canine fossa with a rongeur to introduce the endoscope into the maxillary sinus (►Fig. 2B). Along the way, the infraorbital nerve and artery could be identified at the roof of the sinus after removing the mucosa and polyps.

After entering the maxillary sinus, the orbital floor was opened medial to the infraorbital artery and nerve and laterally to the maxillary ostium. Sharp dissection of the periorbit allowed visualization of the inferior rectus muscle as the first intraorbital anatomical landmark (►Fig. 3A). Further dissection showed the branch of the oculomotor nerve to the inferior oblique muscle laterally to the inferior rectus muscle (►Fig. 3B). The ciliary nerves and the artery could be identified after further dissection and removal of the fat tissue (►Fig. 3C).

After mobilization of the inferior rectus muscle to lateral, the medial aspect of the inferior part of the orbit with its anatomical structures was visible. First, small branches of the ophthalmic artery appeared that had to be protected during further dissection (►Fig. 4A). By following these branches, the ophthalmic artery itself could be identified. The medial rectus muscle with its branch from the oculomotor nerve could be identified in majority of the cases. After further dissection, the optic nerve and the eye ball could be visualized. The entry point of the central retinal artery into the optic nerve could be demonstrated in approximately 50% of specimens (►Fig. 4B, C).

After careful dissection, all relevant anatomical structures of the inferior part of the orbit medially and laterally to the inferior rectus muscle could be identified. ►Fig. 5 shows an overview of the anatomical structures medially and laterally to the inferior rectus muscle (►Fig. 5A, B).

Discussion

Our study demonstrated that the important anatomical structures of the inferior part of the orbit could be identified nicely via the endoscopic transmaxillary approach. This might be relevant for planning endoscopic approaches for tumors or vascular malformations located in this area of interest. However, surgical procedures in the narrow sense are purely endoscopic, rather endoscopy-assisted procedures. We performed an endoscopic route to the orbit and used microsurgical instruments. These procedures are

Fig. 2 The right maxillary sinus. (A) Before perforation. (B) After perforation. L, lateral; M, medial.

Fig. 3 (A) Identification of the inferior rectus muscle medial to the infraorbital artery. (B and C) Lateral aspect to the inferior rectus muscle, branch of the oculomotor nerve, and visualization of the ciliary nerves and artery after deeper dissection. L, lateral; M, medial.

Fig. 4 Medial aspect of the inferior rectus muscle. (A) Superficial. (B and C) Deep dissection. L, lateral; M, medial.

Fig. 5 Overview of the anatomical structures. (A) Medial aspect. (B) Lateral aspect of the inferior rectus muscle. L, lateral; M, medial.

comparable to endoscopy-assisted surgeries in the pituitary region via a transnasal approach.

At this point, we indicated some important differences between formalin-fixed cadaveric specimens and living tissue. The main difference was the consistency of the fat and muscles, which appeared harder, making dissection more difficult. Furthermore, the tension of the eye bulb was decreased in the cadaveric specimen, indicating the presence of less space during in vivo surgical procedures to identify the presented anatomical landmarks properly. Considering the relatively small space in which the anatomical structures were located, preoperative measurement of the intraocular pressure and evaluation of the possibility to decrease the pressure seemed reasonable.

Furthermore, we wanted to discuss the special findings and pitfalls of this approach. During dissection of the maxillary sinus, mucosa and polyps in different variations were observed, which could hinder identification of the infraorbital nerve. In our study, the infraorbital nerve could not be detected in two cases. This fact can be related to the rough consistency of the mucosa and polyps in the cadaveric specimens. During in vivo surgery, the identification of the nerve should be easier.

Also, anatomical variants of the maxillary sinus and the localization of the infraorbital canal occurred in nearly every case. The bony structure of the orbital floor appeared very thin in nearly all cases. Hence, evaluation of the CT images had to be considered exactly before surgery to prevent damaging the intraorbital structures during opening. Opening the posterior

two thirds of the roof of the maxillary sinus allowed a wide view to the retrobulbar area, though a too far anterior approach hampered the overview. One may orient oneself on the red body of the inferior rectus muscle to be at the right position. Visualization of the white tendon of the inferior rectus muscle indicated the too far anterior approach. Since the fat tissue could hamper visualization of small vessels and nerves, sharp dissection in the orbit should be avoided to prevent damage.

Several studies examined the topographic anatomy of the orbit. To name just a few, Gras-Cabrerizo et al performed an endoscopic endonasal approach to the medial wall of the orbit in human cadavers.³ The authors conclude an adequate exposure of the area between the medial and inferior rectus muscle as a possible surgical corridor.

Roth et al performed an extended transnasal approach to the orbit with two-(2D) and three-dimensional (3D) endoscopes to expose the orbital apex.¹² The authors concluded that the endonasal endoscopic approach provided exposure of the inferomedial aspect of the orbit and orbital apex, which could not be visualized by a transcranial approach.

However, the transnasal view to the orbit appeared similar, but by using a different angle, other anatomical landmarks became more relevant for the approach to the region of interest. It is possible that the transmaxillary approach might have advantages compared with the transnasal approach to avoid the well-known complications, such as epistaxis, mucous damages, or nasal synechiae. However, this is an issue that should be examined in a prospective study. Endoscopic orbital surgery demands time and patience from the neurosurgeon. However, this approach is feasible and may find its place in the neurosurgical armamentarium. Despite differences of the cadaveric tissue compared with living tissue during surgery and the anatomical variations, the knowledge of the topographic anatomy of the orbit could be sufficiently imparted by our illustrations, giving neurosurgeons more safety and the opportunity to become familiar with the endoscopic anatomy.

Conclusion

Knowledge of the topographic anatomy of the inferior part of the orbit could be sufficiently provided by our illustrations. The presented transmaxillary approach allowed a wide overview of the anatomical structures located in the inferior part of the orbit. Our pictorial documentation may provide neurosurgeons more safety and the opportunity to become familiar with the endoscopic anatomy.

Conflict of Interest

We declare that none of the authors have a conflict of interest.

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