O-arm in Endonasal Endoscopic Cranial Base Surgery: Technical Note on Initial Feasibility

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BACKGROUND: **In transsphenoidal endoscopic cranial base surgery, a precise navigational support may be crucial. This is particularly evident when tumors extend to the parasellar region or in recurrent tumors whereas normal anatomy has been altered by previous surgery/radiotherapy.**

METHODS: **Previous unsatisfactory experiences with various navigation techniques in this type of surgery encouraged us to perform an endoscopic endonasal approach with an O-arm (Medtronic, Inc., Minneapolis, Minnesota, USA) assisted technique for the surgical treatment of 4 patients affected respectively by an orbital tumor and 3 cases of relapse of nonfunctioning pituitary adenoma, 1 of them localized in the infrasellar-clival region.**

RESULTS: **The system O-arm-StealthStation allows for merging intraoperative bone 3-D acquisition with preoperative computed tomography/magnetic resonance imaging and provides the surgeon with an extremely reliable operative navigational tool.**

CONCLUSIONS: **This is the first report of an O-arm-assisted endoscopic surgery for cranial base tumors. Here we report on the feasibility and usefulness of such a new application of the O-arm: technical details, setting of the operating room, advantages, and limits of the method are also described.**

Our overall impression, considering the limited number of patients, is that use of the O-arm may be successfully extended to selected cases of cranial base tumors operated through an endoscopic endonasal approach.

INTRODUCTION

Endonasal endoscopic approaches for cranial base tumors represent a valuable surgical choice: Research of new surgical corridors and use of modern instrumentations and technologies have allowed improved clinical and surgical outcomes.

A reliable neuronavigation system is useful in various situations (e.g., when the tumor has a parasellar extension or when usual anatomic landmarks are lacking, such as in the case of conchal-presellar sphenoidal sinus or in the case of repeated surgery).

In our earlier experience, we found that neuronavigation in transsphenoidal endoscopic surgery was sometimes affected by slight inaccuracy, more often detected in the deep sagittal and coronal planes, which was troubling in some complex cases. This problem has been reported with optic and magnetic devices. Thus looking for improved solutions, we sought to verify the feasibility and usefulness of an O-arm–assisted neuronavigation system, already in use at our institution for spinal and functional surgical procedures, in endoscopic endonasal skull-base approaches. The assumption was that the automatic registration of bony structures provided by the 3-dimensional cone-beam computed tomography (CT) acquisition of the O-arm while the patient is in the surgical position, merged with preoperative magnetic resonance/CT images on a neuronavigation workstation, could provide a better reliability compared with standard navigation. To our knowledge, this is the first extensive description of this kind of cranial application for the O-arm.

CASE STUDIES

1) A 52-year-old woman presented with mild right exophthalmos and without visual deficits. Magnetic resonance imaging (MRI) showed an orbital tumor of 2 cm diameter localized inferomedially, close to the apex, displacing laterally and superiorly

Key words
- Endonasal approach
- Endoscopic skull base surgery
- Neuronavigation
- O-arm

Abbreviation and Acronyms
CT: Computed tomography
MRI: Magnetic resonance imaging

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Citation: World Neurosurg. (2018) 117:103-108.
https://doi.org/10.1016/j.wneu.2018.06.015

*Journal homepage: **www.WORLDNEUROSURGERY.org***

*Available online: **www.sciencedirect.com***

the optic nerve (Figure 1A and B). At surgery, through a mononostril approach a total tumor removal was achieved, confirmed by postoperative MRI findings (Figure 1C and D). The postoperative clinical course was uneventful. Pathologic examination revealed a cavernous hemangioma. Duration of surgery: 225 minutes. Absorbed radiation dose: 220 mGy-cm.

2) A 54-year-old male affected by a recurrent nonfunctioning pituitary adenoma (former operation in 2004) involving both cavernous sinuses. In addition, the anatomic picture was complicated by the presence of a partial empty sella and a presellar sphenoidal sinus. At surgery, a subtotal tumor removal was obtained, confirmed by the postoperative CT findings, without cerebrospinal fluid leakage. The clinical course was uneventful. Duration of surgery: 239 minutes. Absorbed radiation dose: 254 mGy-cm.
3) A 71-year-old woman complained of dizziness and headache. An MRI showed an infiltrative tumor involving the sphenoid sinus and the clivus. At surgery a subtotal removal was obtained. The clinical course was uneventful. The pathologic diagnosis was a nonfunctioning pituitary adenoma. Duration of surgery: 180 minutes. Absorbed radiation dose: 253 mGy-cm.
4) A 73-year-old male with clinical history of a nonfunctioning pituitary macroadenoma who underwent microsurgical sublabial surgery in 2009, with a subtotal resection. During the radiologic follow-up, a progressive dimensional increase of residual intrasellar tumor was noticed. At surgery, a total tumor removal was obtained, confirmed by the postoperative CT findings, without cerebrospinal fluid leakage. The clinical course was uneventful. Duration of surgery: 205 minutes. Absorbed radiation dose: 253 mGy-cm.

TECHNOLOGY

O-arm System

O-arm (Medtronic, Inc., Minneapolis, Minnesota, USA) is an intraoperative imaging device that provides 3-D cone-beam CT images through a full 360-degree scan. The O-arm was connected with an optical navigation system (StealthStation S8, Medtronic). With this connection, the images obtained with the OArm are autoregistered and the patient is geolocalized. O-arm images are transferred to the neuronavigation workstation, where they are merged with preoperative CT and/or MRI. For intraoperative navigation, besides standard tools, additional instruments can be calibrated using the SureTrack system. We found out that reliable and useful instruments to navigate are angled and curved suction tips with a diameter of at least 11 Fr. Thinner instruments are somewhat malleable and unfit for optical navigation.

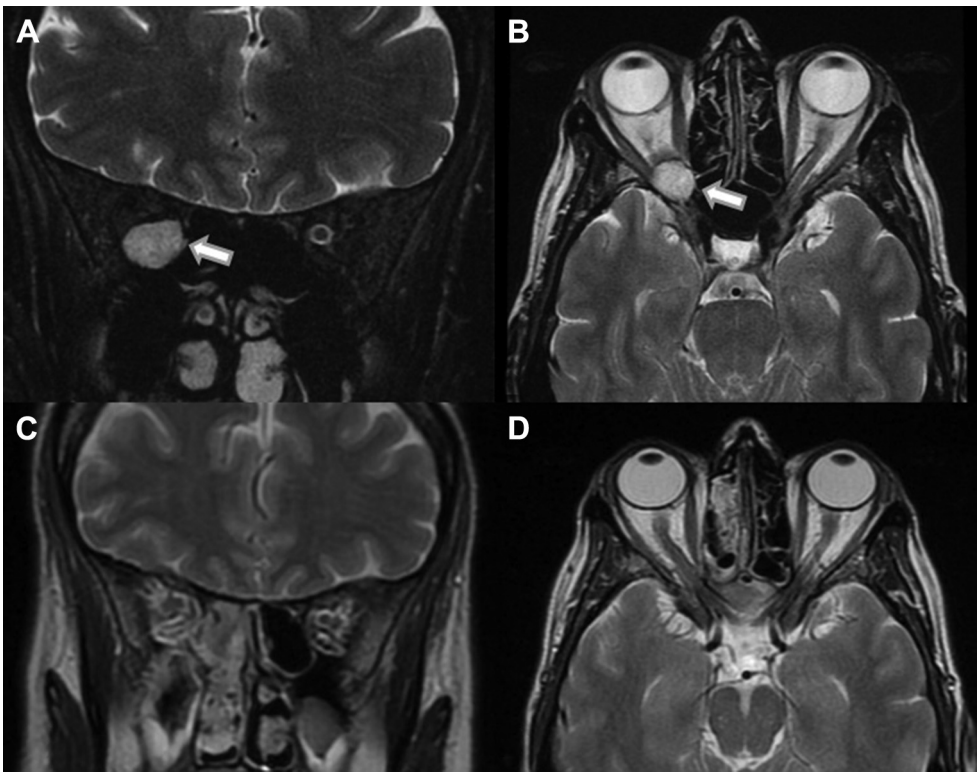

Figure 1. Neuroimaging of Patient 1. Preoperative coronal (**A**) and axial (**B**) T2-weighted magnetic resonance imaging (MRI) showing an extraconal tumor at the orbital apex (*arrows*). Postoperative coronal (**C**) and axial (**D**) T2-weighted MRI showing complete tumor resection.