Palatal Position of Patient Tracker for Magnetic Neuronavigation System: Technical Note

Giuseppe Catapano[1], Francesco Giovanni Sgulò[1], Piedad Elizabeth Acurio Padilla[2], Pietro Spennato[3-5], Giuseppe Di Nuzzo[1], Vincenzo Boniello[6], Matteo de Notaris[1]

■ OBJECTIVE: **Recently, the neuronavigation system (NS) has become an essential intraoperative tool for many neurosurgical procedures, allowing for precise lesion localization. It is particularly important to avoid errors during the navigation process. Here we report a novel technique using palatal positioning of the patient tracker to ensure optimal accuracy during magnetic navigation in various neurosurgical procedures.**

■ METHODS: **This retrospective study included a total of 34 patients treated in our institution between June 2017 and January 2018. The patients were split into 2 groups who underwent surgery under general anesthesia: a microscopic transcranial group and an endoscopic endonasal group. Preoperative and postoperative navigation accuracy was assessed by 2 neurosurgeons.**

■ RESULTS: **After our surgical planning navigation protocol was applied, both transcranial and endonasal procedures were successfully performed under navigation guidance in all but 1 patient. There were no intraoperative or postoperative complications related to the tracker mounted under the hard palate. In 33 cases a maximal tracking view and optimal navigation accuracy was achieved, for a success rate of 97%.**

■ CONCLUSIONS: **The positioning of the patient tracker under the hard palate proved safe, accurate, and feasible in 97% of our patients. In our case series, it met the main goal of avoiding device displacement without a sense of invasiveness and postoperative patient discomfort.**

INTRODUCTION

In recent years, the neuronavigation system (NS) has become an essential intraoperative tool for many neurosurgical procedures, allowing for precise lesion localization in a minimally invasive "tailored" surgical approach.[1] For this reason, accuracy of positional information is the main issue for the clinical application of this technology[2] in various areas of neurosurgery, including brain tumor resection, frameless biopsy, neuroendoscopy, and transsphenoidal surgery.[3,4]

Indeed, electromagnetic (EM) NSs offer the advantage of performing pinless procedures without the need for head fixation and without line-of-sight issues.[1,4-7] As in optical systems, probes and tracked surgical tools of EM systems must be coupled to a dynamic reference frame (DRF) and a field sensor.[8] However, they can cause intraoperative navigation issues and interruptions, especially due to the presence of ferromagnetic devices near the surgical field.[8,9] For this reason, it is particularly important to avoid a cumulative error during all navigation steps. Localization errors increase with the offset of the EM sensor and range from 0.25–50 mm to 0.97–300 mm offset from the sensor.[8,10] The type and location of DRF are key points in the use of this technology, with positional problems implicated in up to 50% of localization errors.[8,10] DRF displacement is an application error,[8,11] creating a mismatch between the actual

Key words
- Magnetic tracker
- Neuronavigation
- Surgical accuracy
- Surgical planning

Abbreviations and Acronyms
DRF: Dynamic reference frame
EM: Electromagnetic
ICA: Internal carotid artery
MRI: Magnetic resonance imaging
NS: Neuronavigation system
TRE: Target registration error

From the [1]Department of Neuroscience, "G. Rummo" Hospital, Neurosurgery Operative Unit, Benevento, Italy; [2]Neurosurgical Unit, Universidad de Ciencias Médicas de La Habana, Cuba; Departments of [3]Pediatric Neurosurgery, [4]Pediatric Neuroradiology, and [5]Pediatric Oncology, Santobono-Pausilipon Children's Hospital, Naples; and Department of Neuroscience, "G. Rummo" Hospital, Neuro-Intensive Care Unit, Benevento, Italy

To whom correspondence should be addressed: Matteo de Notaris, M.D., Ph.D. [E-mail: matteodenotaris@gmail.com]

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Table 1. Comparison of the 2 Surgical Groups

Approach	Number of Patients	Pathology, number	Region, number	Accuracy, %
Microscopic transcranial	22	Tumor, 20 Vascular, 2	Frontal, 7 Temporal, 6 Parietal, 4 Occipital, 3	94.5
Endoscopic endonasal	12	Tumor, 12	Sellar, 10 Suprasellar, 2	100

position of the navigated tool tip and the corresponding actual position of the surgical target, known as target registration error (TRE).[8,9]

In the present study we focused on EM tracking, describing DRF mounting under the hard palate in 34 different neurosurgical procedures to ensure the permanent maintenance of optimal accuracy during various neurosurgical procedures.

METHODS

Prestudy Phase

Oral DRF attachment was first evaluated in the clinical applications reported by Bale et al.[12] and Suess et al.,[13,14] for which it demonstrated safety, feasibility, and accuracy. Moreover, after questioning the manufacturer, we used the technique in 10 patients in whom other intraoperative image guidance technologies were being applied concomitantly.

Patients

This retrospective study included a total of 34 patients treated in our institution between June 2017 and January 2018. The patients were split into 2 groups who underwent surgery under general anesthesia: 22 patients treated with a microscopic transcranial approach and 12 patients treated with an endoscopic endonasal approach (Table 1). The first group comprised 20 patients with a brain tumor and 2 with a vascular malformation. The brain lesions were located in the frontal lobe in 7 patients, the temporal lobe in 6 patients, the parietal lobe in 4 patients, and the posterior cranial fossa in 3 patients. Positioning for surgery was supine in 13 patients, lateral in 4 patients, and park bench in 3 patients. The second group included 10 patients with a sellar tumor and 2 patients with a suprasellar region tumor, all operated on in the supine position.

Navigation and Operative Protocol

All patients underwent preoperative brain magnetic resonance imaging (MRI; Signa Excite 1.5 T; GE Healthcare, Little Chalfont, UK) at our institution within the week before surgery. Standard imaging acquisition protocols for neuronavigation were followed (i.e., contiguous slice of 1.5 mm thickness including the hard palate, tip of the nose, and ears, up to the vertex). T1-weighted postgadolinium MRI sequences (32 patients) or T2-weighted MRI sequences (2 patients) were obtained according to the neuroradiologic characteristics of the disease to be operated.

In all cases, surgery was performed under intraoperative guidance provided by AxiEM technology with the StealthStation S7 System (Medtronic, Minneapolis, Minnesota, USA). Once the patient was properly positioned, the noninvasive DRF was mounted under the hard palate, next to the orotracheal tube (Figure 1). In our experience, we prefer to not use any preoperative imaging studies showing the anatomy of the hard palate before the surgical procedure, opting instead to verify the feasibility of the technique (i.e., palate compatibility, orotracheal intubation, patient position, and surgical approach) directly on the patient. In cases where we could not apply the DFR in a subpalatal location, we used a standard skin position. Patients with previous dental work (e.g., dental prostheses/bridges) were systematically excluded.

The tracker was then gently dabbed by gauze to ensure a fixed immobilization (Figure 2A and B). An EM field emitter was placed in the holder and positioned so as to maximize the navigation field volume throughout the range of

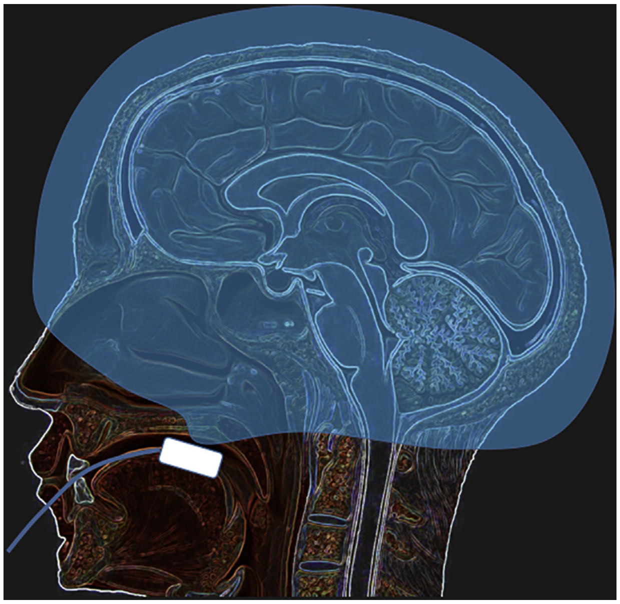

Figure 1. Schematic drawing illustrating the optimal navigation field volume obtained after the positioning of the noninvasive dynamic reference frame under the hard palate.