**Technical Note**

**Electromagnetic Navigation-guided Neuro-endoscopy: Technical note.**

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**ABSTRACT**

Advances in technology enable neurosurgeons to use the Electromagnetic image-guided navigation in combination with a rigid neuro-endoscope for accurate positioning of the scope within the cerebral ventricles, and in identification of the intraoperative anatomy distorted by pathologic conditions. This technique enables precise, safer, and faster surgery by finding the way in the brain and avoiding injury. The operative technique described here is the first neuro-endoscopy technique guided by the electromagnetic navigation system using the AxiEM™ Styret during the procedure. The procedure is carried out using AxiEM™ Electromagnetic Stealth Station® Navigation System preloaded with the patient’s brain CT or MRI scans in combination with a GAAB neuro-endoscope.

**INTRODUCTION**

Electromagnetic (EM) navigation has become an integral part of neurosurgical procedures, particularly in pediatric age group. It has proven to be a great device for surgical treatment of variable neurosurgical problems. Electromagnetic navigation was also found very useful when combined with neuro-endoscopy especially when neurosurgeons encounter some confusion by a pathological distortion of the normal anatomy in a limited endoscopic surgical view. It provides continuous measurement of the tip position and the orientation of the endoscope relative to the patient's head.

The development of EM navigation has allowed pediatric neurosurgeons to use image-guided navigation in infants and young children in whom rigid fixation in cranial pins is contraindicated. AxiEM™ EM navigation-guided neuro-endoscopy is now used for several applications including endoscopic third ventriculostomy, insertion of shunt catheter, fenestration of cystic lesion and multiloculated hydrocephalus, septum pellucidotomy, aqueductoplasty and fenestration of isolated fourth ventricle. It can be used also for biopsy or resection of intraventricular and periventricular lesions.

The technique and the author's experience of its use are described.

** Technique:**

Patients are scanned (CT or MRI) for Stealth Station at Sheikh Khalifa Medical City using the following protocol:
- Contiguous, non-overlapping axial slices.
- Slice thickness is 1.25 mm.
- Tip of the patient’s nose should be included in the scan.
- Scans are taken without Gantry tilt.
- The patient head is separated from the scanner headrest with towels or foam.
- Contrast agents may be injected before scanning.

The operation room setting is arranged with endoscope and navigation monitors are kept beside each other and in front of the surgeon (Figure 1). The patient is positioned supine and head is supported on a headrest slightly flexed at a 30-degree angle and the registration process with the neuro-navigation is then carried out. After preparation of the skin, a curvilinear incision is made. Trimming of the edge of the anterior fontanel is done approximately 2 cm from the midline, at the level of the mid-pupillary line to make an 8 mm hole just to the front of the coronal suture. Once the dura is exposed it is coagulated and opened.

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Fig. 1a&b: Setting of the operation theatre; monitors are in front of the surgeon. a: Endoscope monitors viewing an arachnoid cyst filling the third ventricle and occluding the foramen of Monro. Note tip of the AxiEM™ Stylet is seen at 10 O’clock of the endoscope view (arrow). b: Navigation monitors showing the exact location of the endoscope tip (2 arrows).

The AxiEM™ Stylet (Figure 2-A) is introduced into the fenestrated stylet of the operating sheath of the endoscope and gradually passed through the brain into the lateral ventricle under constant navigation control allowing accurate navigation in the line of the trajectory and directed to the target point. Both stylets are removed from the working channel and the insertion into the lateral ventricle can be confirmed by the egress of CSF. The telescope is carefully inserted into the working channel. The AxiEM™ Stylet is afterwards introduced into the scope, its tip is usually visible (Figure 2-B), and is guiding the surgeon through the process of navigation of the ventricle, which made immediate verification of the endoscope’s position possible. The subsequent slow movements of the endoscope are visually controlled while the tip of the endoscope is precisely located in the neuro-navigation monitor. Prior to inserting the instruments in the operating channel the Stylet is removed. While the procedure is going on and for the purpose of confirmation of the actual position of the endoscope, the Stylet is reintroduced into the working channel of the endoscope. The endoscope tower can be connected to the navigation monitor and video view is displayed beside the navigation images (Figure 3).

At the end of the procedure after retrieval of the endoscope, Gelfoam is used to plug the opening and suturing of the skin is performed in routine fashion.

Fig. 2a-c: a: AxiEM™ Stylet of the electromagnetic neuro-navigation. b: (1) Shaft of GAAB endoscope, (2) AxiEM™ Stylet passed into the scope, (3) Rubber adaptor with AxiEM™ Stylet passed through its hole, (4) Distal end of the endoscope with (5) tip of the stylet seen through it. c: Endoscope with the stylet introduced into the patient’s brain during surgery.
DISCUSSION

Electromagnetic image-guided neuro-navigation has expanded the application of navigation in intracranial neurosurgery, because the optical navigation systems needed rigid pinning cranial fixation, they are not suitable for very young patients.1,3

Initial reports on image-guided neuro-endoscopy used frame-based stereotaxy. Subsequently, Rhoten, et al.10 used a frameless and armless stereotactic system combined with neuro-endoscopy. They used an optical tracking system in their study, where they fixed the patient’s head in position during the procedure. In EM navigation guided neuro-endoscopy, the head of the patient is not pinned and can be freely mobilized to the best operating position. We found this application to be particularly useful when pinning is contraindicated in infants and very small children.

Preoperative images obtained using navigation protocol are uploaded to the Stealth Station AxiEM™ EM navigation. This provides the ability to align the desired trajectory and confidence in the knowledge of the exact position of the tip of the AxiEM™ stylet and tip of the endoscope, throughout navigating the endoscope. The rigid working channel does not allow deflection of the stylet, which assures insertion in a well-aligned trajectory that cannot miss the ventricle.

The operating room setting is set up; the endoscope monitor is in front and aside to the navigation monitor. Neuro-navigation images of the anatomy and pathology are viewed along with real-time endoscopic live images providing augmented reality. We overcome the need for switching the surgeon’s focus between two screens by displaying the video streaming on the same navigation data workstation screen, which helps in easy orientation between the two views (Figure 3).

By using this technique, we can abandon free hand placement of the neuro-endoscope, where no navigation information is available to help align the telescope trajectory, particularly when there is variation in ventricular anatomy and anatomical landmarks that make it difficult to insure that the tip of the scope is in the right path. Similar techniques proved useful in reducing and managing complications during common intraventricular neuroendoscopic procedures including ETV, colloid cyst resection, tumor biopsy and resection, and treatment of multiloculated hydrocephalus.11

One drawback to this technique is the need for intermittent insertion of the Axiem™ Stylet into the endoscope to localize the current endoscope position. This problem might be overcome in the future by developing an integrated navigation system specifically designed for neuro-endoscopic procedures. Another disadvantage of this technique is that it cannot be applied to flexible endoscope.

CONCLUSION

Using the AxiEM™ Stylet during navigation-guided neuro-endoscopy allowed accurate navigation of the endoscope in the line of the trajectory and safely reaching the target without injuring the brain. This technique allowed immediate localization and orientation of the endoscope tip all through the procedure.

Electromagnetic navigation-guided neuro-endoscopy procedure did not add significant time to the operation. In fact, it reduced operating time by facilitating rapid and accurate endoscope placement.

Conflict of Interest:
The author states no conflict of interest with the named product or the company mentioned in the article or to a company that markets a similar product.

REFERENCES


