Simple Improvisation to Enhance Utility of Fluorescein Sodium in Resection of Intracranial Lesions at Routine Neurosurgical Centers

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■ INTRODUCTION: **Fluorescein sodium is one of the fluorophores that is used in the resection of intracranial lesions. It is commonly used along with a customized microscope, which is expensive and not available universally. In this study, we describe a simple, inexpensive method for better visualization of intracranial and spinal cord lesions with fluorescein.**

■ MATERIALS AND METHODS: **After a test dose, 20 mg/kg of fluorescein sodium was administered intravenously at the time of intubation. A blue light source was used before resection for precise localization of the intracranial lesions after durotomy. Most of the resection was done under the white light, while the blue light was used intermittently to delineate the pathologic tissue from the normal tissue and to ensure safe maximal resection. The intensity of fluorescein staining under white light and blue light was noted.**

■ RESULTS: **The study comprised 40 cases of gliomas, meningiomas, abscesses, spinal cord tumors, and cerebellopontine angle lesions. Thirty-five lesions showed good fluorescence under the blue light, which helped us achieve better resection of the pathologic lesions.**

■ CONCLUSIONS: **Fluorescein sodium is a safe dye; it can be used to aid in precise localization and safe maximal resection of the pathologic tissue with the help of a blue light source at any center with challenged resources. The blue light enhances the fluorescence and visualization of the pathologic tissue, and this technique can be adopted by any surgeon without much difficulty even with a basic neurosurgical setup.**

INTRODUCTION

Intracranial space-occupying lesions (ICSOLs) constitute a spectrum of disorders including tumors, infections (abscesses and granulomas), hematomas, and cystic lesions. Most of these lesions require surgical excision. The principal goal of neurosurgical excision includes precise localization and resection of the pathologic tissue without sacrificing the normal brain parenchyma. However, differentiating the pathologic tissues from the normal brain parenchyma is not always easy and the neurosurgeons tend to err toward incomplete resection. But there is strong evidence in the literature to suggest that the extent of resection plays an important role in the prolongation of overall survival and progression-free survival.[1]

A number of technologic advances have been made recently to assist the neurosurgeons in complete and safe resection of the tumors and other ICSOLs. Fluorescein is one such adjunct used in the resection of ICSOL. Other compounds that have been in use are 5-aminolevulinic acid and indocyanine green.[2] These compounds require additional equipment that is not available universally.

Fluorescein sodium is a low-molecular-weight fluorophore that is used in diagnostic angiography by ophthalmologists. It has also been used by neurosurgeons in vascular and tumor surgery. Fluorescein has been increasingly used in recent years as its low

Key words
- Blue light
- Fluorescein
- Fluorescence-guided resection
- Without microscope

Abbreviations and Acronyms
ICSOL: Intracranial space-occupying lesion
LED: Light-emitting diode
MRI: Magnetic resonance imaging
SOL: Space-occupying lesion

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cost and safe therapeutic profile make it a good adjunct in the resection of tumors.[3]

A surgical microscope with dedicated filters is essential to maximize the utility of fluorescein sodium. Though fluorescein can be used without a microscope, higher doses are required to stain the tissues. In this study, we describe a simple and cost-effective method to maximize the utility of fluorescein in the resection of intracranial lesions at centers without sophisticated equipment.

PATIENTS AND METHODS

Patients with ICSOLs who were operated on between January 2017 and August 2017 were included in the study. The patients with known cardiac, respiratory, and renal disorders were excluded, as were those with known hypersensitivity to fluorescein. Patients unwilling to participate in the study were also excluded.

Approval was obtained from the Institutional Ethics Committee. Informed consent was taken from all the patients.

Procedure

On the day before surgery, a test dose of 0.05 mg of 20% fluorescein sodium is given on the forearm and the site is marked. The site is checked for hypersensitivity reactions and signs of respiratory distress are also looked for. Preoperative scans were checked for contrast enhancement.

After intubation, 20 mg/kg of fluorescein sodium are injected via a dedicated intravenous line and the dye is flushed after injection.

A commercially available blue light-emitting diode (LED) light source is added to the overhead operating room lights. This blue LED light is used to note the fluorescence before the resection. Most of the procedure is done under white light. The blue light is used intermittently to ensure the resection is complete. At the end of the procedure, the resection cavity is inspected under blue light for residual fluorescence. In some cases, we have also used a magnifying glass with an inbuilt blue light source for closer inspection of the resection cavity.

The amount of staining and fluorescence is recorded under white light and blue light, respectively. All the tissues with intense fluorescence under the blue light are resected and sent for histopathologic examination.

Postoperatively, the patient is observed for 24 hours or longer depending on the neurologic status. Postoperative magnetic resonance imaging (MRI) with contrast is taken on the next day. The extent of resection is recorded as per the MRI findings or the operating surgeon's assessment. No residual enhancement on postoperative MRI was considered as gross total resection and any residual contrast-enhancing lesion on postoperative MRI is considered as subtotal resection. For meningiomas, Simpson grade 1 excision was labeled as gross total resection.

RESULTS

A total of 40 cases were included in the study. Gliomas were the most common tumors, followed by meningiomas. Among these cases, 35 showed enhancement of tumor/space-occupying lesion (SOL) on the preoperative scan. All these cases showed intense staining (under white light) and fluorescence (under blue light). The 5 cases that had not shown enhancement of the tumor on the preoperative scans did not show staining or fluorescence during surgery (Table 1).

Table 1. Case Profile

Diagnosis	Number of Cases
High-grade glioma	15
Low-grade glioma	5
Meningioma	7
Metastasis	5
Abscess	3
Cerebellopontine angle tumor	3
Spinal cord tumor (neurofibroma)	2

Gross total resection was achieved in all the cases of metastases, spinal cord tumors, and abscesses. Gross total resection was achieved in 12 cases of gliomas. Planned subtotal resection was done in the rest of the cases ($n = 8$, including 3 cases that demonstrated fluorescence and 5 cases that did not show any fluorescence or staining). Subtotal resection was done in all the cases of cerebellopontine angle SOL.

DISCUSSION

Fluorescein sodium is a fluorophore commonly used in retinal angiography. The use of fluorescein in the excision of gliomas and meningiomas was first described by George E. Moore in 1947, wherein ultraviolet light was used to observe the fluorescent tumor tissue.[4] There has been a renewed interest in fluorescein sodium in recent years as a tool to achieve greater resection rates in the field of neurosurgery. Fluorescein has been used in the resection of gliomas,[5,6] meningiomas,[7] cerebral metastases,[8] lymphomas,[9] arteriovenous malformations, aneurysms, and spinal cord

Figure 1. Fluorescein-stained glioma under white light.