Training Protocol for Intracranial Pressure Monitor Placement by Nonneurosurgeons: 5-Year Experience

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Background: This report evaluates a protocol for training nonneurosurgeon medical staff to perform ventricular catheter placement for ICP monitoring in traumatic brain injury and other appropriate patients under the guidance of neurosurgeons.

Methods: Eleven neurosurgery house officers were enrolled in the program to be certified for ventricular catheter placement. The training program using the Ghajar Guide is described as well as the preprocedural checklist. The results of these certified house officers were tracked over a 5-year period.

Results: Ten house officers successfully completed the certification process for ventricular catheter placement in a total of 106 patients. The majority of ventricular catheters were placed at the bedside. The reported results and the complication rates of catheter-related infections and intracranial hemorrhage are similar to that of neurosurgeons or neurosurgeons in training.

Conclusion: House officers under the guidance of neurosurgeons can be trained to successfully and safely place ventricular catheters for ICP monitoring in patients needing ICP monitoring.

Key Words: Ventricular catheter, Ventriculostomy, Intracranial pressure monitoring, Brain injury, Neurosurgeon, Neurosurgery house officer.

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The use of intracranial pressure (ICP) monitoring in the treatment of severe traumatic brain injury (TBI) patients is the customary practice[1] in many major trauma centers. ICP monitoring via ventriculostomy is the "gold standard" for the measurement of intracranial pressure because of accuracy and the possibility of therapeutic cerebrospinal fluid (CSF) drainage for the control of elevated ICP. However, national surveys of practice[2] and of trauma surgeons[3] indicate that there is sometimes a reluctance to place ICP monitors in appropriate TBI patients and it is used in less than 50%[2] of surveyed facilities. This disinclination may stem from the shortage of neurosurgeons available to cover and manage neurotrauma or from the lack of immediate availability of a neurosurgeon to place an ICP monitor. Training ancillary medical personnel to place ICP monitors under the supervision of a neurosurgeon may alleviate this problem. This report describes and evaluates a training program that was developed to address this issue at a Level I trauma center as a means of assisting neurosurgeons in fulfilling immediate ICP monitoring placement needs.

PATIENTS AND METHODS

The study was accomplished at Jamaica Hospital Medical Center, a Level I trauma center in Queens, New York, during the period from August 1991 to September 1996. The trauma service is staffed by general surgery residents and an on-site "house officer" assigned to the neurosurgery service. Two neurosurgeons supervised the training program and the patients were assigned to the care of each neurosurgeon on the basis of the emergency coverage schedule. The neurosurgery house officers evaluated over the 5-year period consisted of 11 individuals, 8 holding MD degrees with at least 1 year of postgraduate training and 3 physician assistants. The house officers underwent training for ventricular catheter placement for ICP monitoring in TBI and other appropriate patients. The training protocol consisted of a didactic session with written instructional material covering the intracranial anatomy and the procedure for ICP monitor placement. In addition, a demonstration video of the procedure was available for reference. The candidate observed and assisted in five catheter placements by the neurosurgeon or a previously certified neurosurgery house officer. Thereafter, the candidate was certified after the successful placement of five ventricular catheters under the direct observation of a neurosurgeon. Each ventricular catheter was inserted using the Ghajar Guide Ventriculostomy kit (80-1185, Codman & Shurtleff, Raynham, MA) and technique. This device enables the perpendicular drilling of the skull and placement of the catheter into the ventricle[4] along the correct trajectory (Fig. 1). In all patients, the frontal scalp was shaved and prepared with sterile technique. A 0.5-cm linear incision was made, followed by drilling of a burr hole 10 cm above the nasion and 3 cm laterally. In patients with midline shift, the entry site was positioned an extra centimeter laterally on the side of the ventricular shift. The catheter was inserted to a depth of 5.5 cm from the inner table of the calvarium. After the egress of CSF, the distal catheter was tunneled away from the insertion site and brought out through a separate incision to connect to the closed drainage system. Ventriculostomies performed in the

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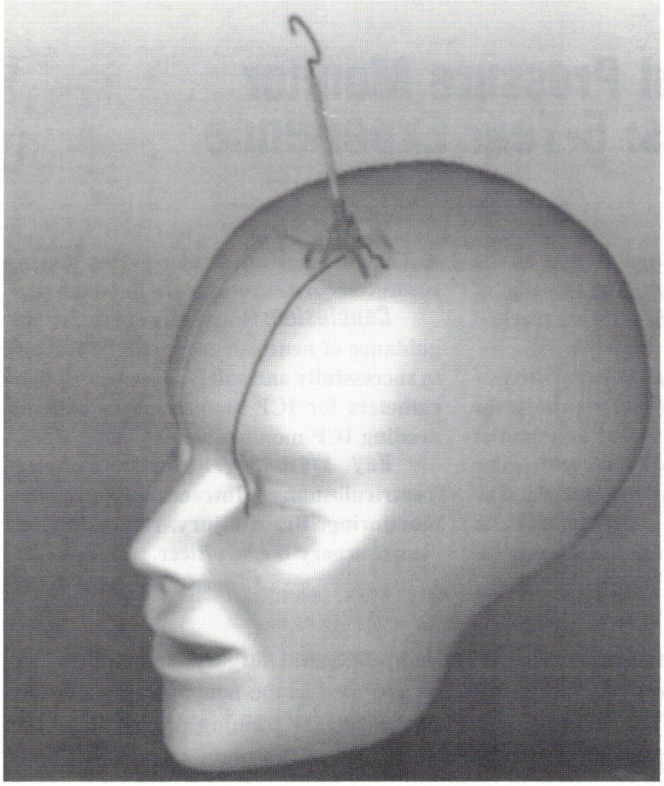

Fig. 1. *Schematic diagram of the Ghajar Guide positioned over the burr hole for ventricular catheter insertion. The* heavy line *indicates the midline and the* thin line *3 cm lateral to this at the entry point.*

operating room were completed after removal of any mass lesion by craniotomy. For this study, no antibiotics were given at the time of insertion; however, this practice has since changed to include one intravenous dose of preprocedure antibiotic. In pediatric patients, aged 17 years or younger, ventriculostomies were performed only by neurosurgeons. In addition to the above, each candidate had to demonstrate competence in ICP management, ventriculostomy care, and basic troubleshooting. After certification, the house officer followed a standard protocol each time a severe TBI or other appropriate patient was seen in the emergency room. The protocol included documentation of medical history; a detailed neurologic examination including the Glasgow Coma Scale (GCS) score; and verification of a normal coagulation profile including platelet count, international normalized ratio, prothrombin time, and partial thromboplastin time. A non–contrast-enhanced computed tomographic (CT) scan of the brain was completed and transmitted via teleradiology for review by the neurosurgeon.

If there was no neurosurgical mass lesion requiring craniotomy, the house officer was instructed by the neurosurgeon to place a ventricular catheter in the side without intracerebral disease after consent indicating that laterality was obtained. The house officer was allowed only two passes of the catheter to achieve ventricular entry. If unsuccessful after two passes, further attempts by the house officer were not permitted and ventricular cannulation was then completed by the neurosurgeon.

A functioning ventricular catheter was proven by the observation of a standard waveform with pressure readings and CSF drainage. The policy was to obtain a non–contrast-enhanced CT scan of the brain on all patients within 24 hours of ventriculostomy depending on the intracranial pressure measurements and also on whether the patient's condition enabled transport. In cases where ventricular cannulation was in question, the catheter was left in place and an immediate CT scan was obtained to ascertain position. Each follow-up CT scan was reviewed by the neurosurgeon to note final ventricular catheter position. A CT scan showing the catheter positioned in the right or left lateral ventricle or the third ventricle was radiologic evidence of successful intraventricular cannulation. Secondary catheter reposition because of dislodgement, malfunction, or extended monitoring was performed by the neurosurgeon.

The results of ventricular catheter placement by the house officers after certification were tracked along with patient data. Although two neurosurgeons were involved in the training process, the results listed below are limited to the activity of only one neurosurgeon. The second neurosurgeon declined to participate in this study because of a financial conflict of interest with the outcome of this report.

RESULTS

Eleven house officers were enrolled in the training program over a 4-year period, with data accrual lasting 5 years. Approximately two to three house officers were active on the service per year. A total of 10 house officers successfully achieved competency and were certified for this procedure. In general, candidates (n = 8) with surgical backgrounds were proficient immediately at the end of the training session; others (n = 3) took more than five ventricular catheter placements to become certified. One candidate was unable to satisfactorily perform the procedure after training under the direction of the neurosurgeon and discontinued attempts to become certified. The competency process from the initial training to certification took between 2 and 4 months. The ventricular ICP monitor placement results of the certified house officers were analyzed.

During this period, 134 patients had ventricular catheters placed by certified neurosurgery house officers under the supervision of one neurosurgeon. Of these, 28 were excluded because of the inability to obtain complete medical records for review; these cases were random and not selective in time or by specific house officer. Of 106 cases with an average GCS score of 6, the average age was 49 years, with 67% male and 33% female patients. Sixty-four ventriculostomies were completed in the surgical intensive care unit and emergency room, with the remainder (n = 42) being placed in the operating room. The diagnosis for patients requiring ICP monitor placement is indicated in Table 1.

Table 1 Diagnosis of Patients Undergoing Ventricular Catheter Placement by House Officer

Diagnosis	No.
Epidural hematoma	4
Subdural hematoma	16
Closed head injury	32
Arteriovenous malformation	3
Intracranial hemorrhage	27
Gunshot wound to the head	13
Comminuted skull fracture	2
Intraventricular hemorrhage	5
Infarct	4

A total of 16 patients (15%) had catheters repositioned by the neurosurgeon after the house officer failed to achieve placement after two attempted passes. The most common reason for malplacement was inadequate catheter length, that is, although the catheter was placed on the correct course, the catheter length was inadequate and therefore short of the ventricle. No catheter was placed beyond the third ventricle. There were no complications related to the repositioning of any catheter.

There were three catheter-related infections (3%) manifested by fever, elevated white blood cell count, and positive CSF cultures. These cases were treated by catheter replacement or removal and intravenous antibiotics. All three patients responded to this treatment without a decline in the preprocedural GCS score. There were three cases (3%) of new blood present without mass effect around the catheter track on the immediate postprocedure CT scan, none of which required surgical evacuation or resulted in the deterioration of the GCS score or new focal neurologic deficit. These results are shown in Table 2. Overall, 66 patients survived to be discharged home or to be transferred to postacute care facilities.

DISCUSSION

This report describes the results of a neurosurgeon-supervised training protocol for the placement of ICP monitoring via ventricular catheter by medical house officers. Because the process is rigorous, only those individuals willing to make a long-term commitment to neurosurgery should be enrolled in this training program.

To our knowledge, this present work is the first study to evaluate ventricular catheter placement by nonneurosurgeons. These results show that with this training regimen, ventricular catheters for ICP monitoring can be safely and accurately placed by house officers who have undergone and successfully completed the certification process. Furthermore, the results demonstrate that nonneurosurgeon medical staff can be trained to place intraventricular catheters with results similar to that of neurosurgeons.[5,6] This report supports the results of earlier studies that confirmed the safe and successful placement of subdural fiberoptic ICP monitors by midlevel practitioners,[7] anesthesiologists,[8] and intensive care physicians.[9] Furthermore, this protocol has been successfully used to train and certify other medical staff members subsequent to this study at other facilities.

Fifteen percent of catheters had to be repositioned by the neurosurgeon without any residual clinical implications. This was observed more frequently with the newest trained staff members and diminished with experience. The Brain Injury Task Force reports a lower malposition rate of 3% for neurosurgeons, understandable given the lengthy and extensive neurosurgical training each undergoes.[1] We report 3% ventricular catheter-related infections, which is below the reported incidence of 10%.[5] The finding of new hemorrhage after ventriculostomy without clinical significance in this study is 3%, compared with 1.4% detailed by the Brain Injury Task Force.[1] Furthermore, the probability of procedure-associated significant intracranial hemorrhage requiring operative intervention is 0.5% in the same reference, compared with none in our analysis.

Table 2 Complications of Ventricular Catheter Placement by House Officer

Complications (n = 106)	%
Catheter reposition	15
Catheter infection	3
Hemorrhage along catheter track	3

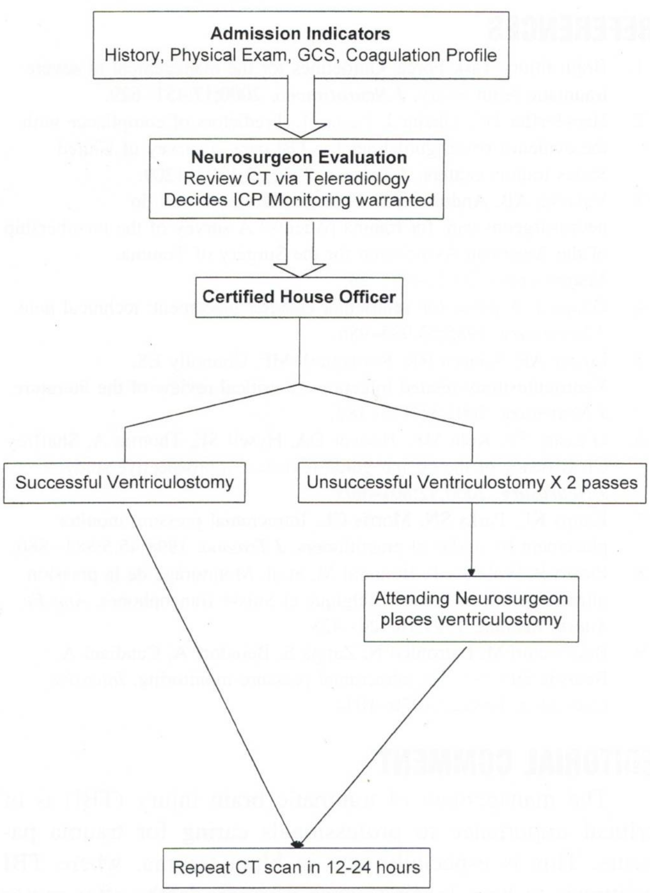

Fig. 2. *Protocol for ICP monitor placement by house officer.*

The success of this training program rests on the following. First, a neurosurgeon is required to direct the training program and to supervise the house officers. Guidance by an experienced neurosurgeon is mandatory at all points in the workup of each patient. The decision to place a ventricular catheter is made by the neurosurgeon. Second, a reliable teleradiology system to transmit the brain CT scan is also required to aid the off-site neurosurgeon in decision making. Third, the use of the Ghajar Guide simplifies the placement of a ventricular catheter by providing a means to cannulate the ventricle in a stressful emergency situation, especially for those who lack formal neurosurgery training. Even practicing neurosurgeons specializing in neurotrauma may benefit from using this device.[6]

The protocol for ventricular catheter placement for ICP monitoring is summarized in Figure 2. This training and certification program under the direction of experienced neurosurgeons may offer an option when he or she is not instantly available or in geographical areas that do not offer neurosurgery residency training programs. If a hospital lacks immediate access to formally trained neurosurgery staff, this report suggests a solution for ensuring the availability of ventricular catheter placement for ICP monitoring and optimal treatment of elevated ICP in appropriate patients.

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EDITORIAL COMMENT

The management of traumatic brain injury (TBI) is of critical importance to professionals caring for trauma patients. This is especially true in blunt trauma, where TBI continues to be a leading cause of early deaths after motor vehicle crashes, falls, and other nonpenetrating injury.

Although much research has been conducted in the pathophysiology of TBI, significant controversy continues to plague the management of this important injury.[1,2] Surveys have shown that substantial variation exists in the management of TBI, throughout the United States, even among designated trauma centers. Attempts to alleviate this dramatic diversity have included the development of the guidelines for the management of severe brain injury by the Brain Trauma Foundation in collaboration with the American Association of Neurologic Surgeons.[3] Among the major recommendations of these guidelines has been the adoption of intracranial pressure (ICP) monitoring for severe TBI (Glasgow Coma Scale score of 8 or <8) and the aggressive management of cerebral profusion pressures with the goal of avoiding secondary brain injury. Although there are no conclusive data to support these recommendations, the application of these guidelines in an organized, protocol-driven approach has resulted in improvement in outcomes in several recent studies.[4–7]

The need to place an ICP monitor is central to the success of such a protocol for severe TBI. However, many centers continue to report difficulty in providing this intervention in their patients.[1,2] Although a number of explanations exist including the above-mentioned lack of conclusive data, there is broad agreement that ICP monitoring is necessary for state-of-the-art TBI care. The possibility that neurosurgeons may not be immediately available or willing to place a ventriculostomy has prompted efforts such as the one reported here to train nonneurosurgeons to place a ventriculostomy. These data demonstrate that it is possible to train physician assistants and other extenders in this technique; that reasonable complication rates result; and that neurosurgeons must continue to be available to assist in difficult placements, interpret results, and provide surgical intervention.

At a time when trauma centers are under continued pressures to stay open, we should explore all options for delivering optimal care for our patients. An experienced neurosurgeon available at the bedside of an injured patient for diagnosis and management (including ventriculostomy placement) remains the ideal. Because there is a relative shortage of neurosurgeons involved in trauma care in many areas and because patients with severe TBI may not need operative intervention by neurosurgeons, the use of extenders and other professionals for placement of ICP monitors provides an important addition to our armamentarium. This will facilitate the application of protocols based on the Brain Trauma Foundation guidelines. Neurosurgeons continue to play a cardinal role in trauma care, but in the current environment of provider shortages, professional liability crisis, and trauma center closures, we must explore all viable options for care delivery to our patients. This work demonstrates that placement of ICP monitors by nonneurosurgeons is one such option. Further study and implementation of this concept is worthwhile.

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