Comparison of Percutaneous Ventriculostomies and Intraparenchymal Monitor: A Retrospective Evaluation of 156 Patients

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Summary

Intraventricular catheters (IVC) and Intraparenchymal fiberoptic catheters (IPC) are the prevalent methods of intracranial pressure (ICP) monitoring. This study assesses the complications caused by either method. Previous studies have shown a higher complication rate with IVC. In 156 consecutive patients, with IVC (n = 104) or IPC (n = 52) insertion, the demographics, Glasgow coma score (GCS), ICP, duration of monitoring, changes in monitoring device, complications and computerized tomography findings, were recorded. The patients were categorized into severe (GCS 3–8), moderate (GCS 9–12) and mild (GCS 13–15) groups. A retrospective, comparative analysis of both techniques was conducted, using Kruskal-Wallis one way analysis of variance with chi square approximation and Mann-Whitney U tests.

The use of IPC at 86.5% predominated in patients with GCS 3–8, while IVC at 81.4% and 92% prevailed in GCS groups 9–12 and 13–15, respectively (p = 0.000). 43.2% IVC were used for 10+ days and 25.9% for 1–3 days, while 80% of IPC were used for less than 6 days (p = 0.000). The complication rate for IVC and IPC was 25% vs 4.4% (p = 0.000). The infection rate was 4.4% and 0.6% (p = 0.1) while, inadvertent removal 4.4% vs 1.2% (p = 0.4), respectively. Malpositions occurred only with IVC (20.1%). All documented complications were without untoward clinical sequelae. We conclude that, IVC remains comparable to IPCs in complications.

Keywords: Complications; percutaneous ICP monitoring; ventriculostomies.

Introduction

ICP monitoring plays an integral part in management of patients with various neurosurgical disorders in a neurosurgical intensive care unit (NICU). The prevalent methods of ICP monitoring and management include, IVC [4,9], which utilizes an external fluid-filled transducer system, and the Camino IPC, consisting of a fiberoptic catheter tipped transducer system [11]. The center where this study was conducted, uses both these methods. Hence, the complications ensuing from either, were compared under uniform circumstances.

Material and Methods

At a level 1 trauma center, of 156 consecutive patients, 104 underwent IVC (Codman & Shurtleff, Inc., Randolph, MA) and 52 IPC (Camino, Neurocare™, Inc., San Diego, CA) insertion. The demographics, GCS, ICP, CT findings, duration of monitoring, any changes in monitoring device and complications were evaluated. The patients were categorized into severe (GCS 3–8), moderate (GCS 9–12) and mild (GCS 13–15) groups, respectively. The cohort was further classified to one of the following five diagnostic groups: Spontaneous Subarachnoid hemorrhage (SAH), closed head injury (CHI), Brain Tumors, Gunshot wounds and miscellaneous (intracerebral hemorrhage, cerebellar hemorrhage, cerebellar infarct, brainstem hemorrhage, granulomatous angitis).

The treatment rendered for raised ICP comprised of the following: sedation, paralytics, hyperventilation, diuretics, cerebrospinal fluid (CSF) drainage and barbiturate coma. The following complications were reviewed: infection, validated by positive catheter tip or CSF culture [10], hemorrhage due to monitor insertion, malposition of monitor, and inadvertent removal. Hemorrhage and malposition were confirmed by CT scans. A retrospective, comparative analysis of the two techniques was conducted, using Kruskal-Wallis one way analysis of variance with chi square approximation and Mann-Whitney U tests.

Results

In the selected cohort, we found the use of IVC and IPC to be 66% and 33%, respectively. Overall, the age ranged from 10–87 years (mean = 49.17 years, median = 50 years). However, there was an age difference noted in the two groups, so that the age means of the IVC and IPC groups were 56.3 and 34.8, respectively (p = 0.000). Amongst the 156 patients,
104 were in GCS 3–8, 27 in 9–12 and 25 in 13–15 (Fig. 1).

The use of IPC at 86.5% predominated in patients with GCS 3–8, while IVC at 81.4% and 92% prevailed in GCS groups 9–12 and 13–15, respectively (p = 0.000). Overall, IVC were changed 62 times and IPC 11 times, respectively. Spontaneous subarachnoid hemorrhage (SAH) was the commonest diagnosis in the IVC group (n = 49); whereas closed head injury (n = 46) comprised the majority of IPC (p = 0.001). While, 25.9% IVC remained inserted for less than 3 days and 43.2% for more than 10 days, 42.3% of IPC were used for less than 3 days and only 3.8% for more than 10 days. Eighty percent of IPC were used for less than 6 days (p = 0.000).

As can be seen from Fig. 2, complications were encountered in 46 cases (29.4%). The IVC group had 25% (n = 39), whereas the remaining 4.4% (n = 7) occurred with IPC (p = 0.000). The infection rate was 5.1% (8 cases); 4.4% (n = 7) with IVC and 0.6% (n = 1) in the IPC group (p = 0.1), respectively. Coagulase negative staphylococci were the most common etiological organisms encountered (n = 4), followed by S. aureus (n = 2) and 1 case each of K. Pneumoniae, Enterobacter aerogenes and Enterobacter cloacae, respectively. In the infected IVC group, a positive blood culture had preceded the CSF infection by 2 days, while a concomitant urine culture was positive in another case. Two types of hemorrhages were found to be associated with catheter insertion i.e., intracerebral hemorrhage (ICH) and intraventricular hemorrhage (IVH). IVH constituted 0.9% (n = 1) of the IVC group, whereas ICH comprised 1.9% each of the IVH (n = 2) and IPC (n = 1) groups, respectively. There were 21 cases of malpositions, all confined to IVC (20.1%); eight occurred in the third ventricle (7.6%) 4 ended in the thalamus (3.8%), 2 in brainstem (1.9%), while 1 each (0.9%) in the foramen of Munro, suprasellar cistern, internal capsule, midbrain, interpeduncular cistern, frontal lobe and temporal lobe, respectively. The incidence of inadvertent removal was 5.7% (n = 9), which included 4.4% (n = 7) in IVC and 1.2% (n = 2) in the IPC group (p = 0.4). Replacement for complication such as mechanical failure or drift was documented in 2.5% cases, of which 0.64% (n = 1) was performed in IVC and 1.9% (n = 3) in IPC.

Discussion

IVC is the accepted “gold standard” for ICP monitoring, with the added advantage of direct control on ICP by CSF drainage, as well as, the ability to administer pharmacological agents via this route. However, they come with an established risk of infection and hemorrhage [9,13], which thus far are complications infrequent with IPCs. Fiberoptic IPC have a comparable accuracy and reliability, with a reading difference of 2–4 mmHg from the IVC [6,12,14]. IVC also need frequent calibration and the requisite fluid-filled column is prone to trapping air bubbles, which in turn may dampen the waveform [2,3]. IPCs are not flawed in this manner, since they comprise of a fiberoptic catheter tip, pressure-sensitive, transducer

![Fig. 1. Distribution of cases into GCS groups at initial presentation. IVC intraventricular catheter, IPC intraparenchymal catheter, GCS Glasgow coma scale](image1)

![Fig. 2. Comparison of complications between intraventricular and intraparenchymal catheters. IVC intraventricular catheter, IPC intraparenchymal catheter](image2)