

Introduction

Percutaneous ventriculostomy is a frequently performed procedure in neurosurgery. Accuracy rates using a freehand technique ranges between 40 - 98%. Complications after a ventriculostomy procedure are not uncommon, with infections and hemorrhage accounting for the most (ranging between 0.2 - 45% and 0.2 - 41%, respectively). An association between the catheter misplacement and catheter malfunction has been demonstrated in various studies. The correlation between the number of attempts to place a catheter and the incidence of postoperative hemorrhage (which would increase the odds of catheter obstruction from heme or debris) has also been studied. In 1985, Jamshid and Ghajar introduced a small tripod device called "Ghajar guide" to assist in proper ventricular catheter positioning. The conventional target for correct positioning of the catheter tip is the foramen ventriculi lateralis (Monro), with the proximal catheter running through the anterior horn of the lateral ventricle. Standard calvarial entry point is Kocher's point (Fig. 1).

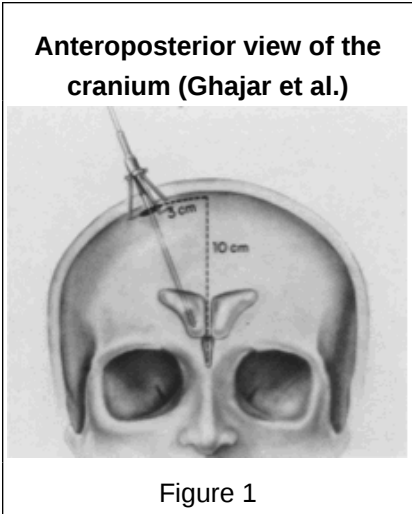


Figure 1

Methods:

- After obtaining the IRB approval, data of patients with hydrocephalus or intracranial hypertension, who underwent electively a first time ventriculostomy placement with the assistance of a Ghajar guide (GG) were collected from the electronic hospital database, patients who had hydrocephalus with presumed distortion of brain anatomy (e.g. subarachnoid hemorrhage or other forms of mass effect from bleeds and brain tumors) were excluded).
- Demographic, clinical, radiological (e.g. preoperative and postoperative head CT scans) and operative data were reviewed.
- We reconstructed all post-placement CTs into a three-dimensional (3D) reformat in order to obtain the following specific measures for each patient: distance from the burr hole to the midline, distance from the burr hole to the supra-orbital ridge, length of the intracranial catheter, and catheter position (whether the catheter crossed or did not cross the brain midline, final intraventricular or extraventricular position of the tip of the catheter), as well as presence or absence of intracranial hemorrhage along the catheter tract.

Results:

Our cohort consists of 146 consecutive patients, mean age was 58.2 yrs (range, 20.0 - 88.3).

The most common indication for intracranial drainage was NPH, followed by post-infectious hydrocephalus, and after prior intracranial hemorrhage. There were 28 (19.2%) patients who had malpositioning of the intracranial catheter. In 26 patients the catheter crossed the midline and was translocated to the contralateral ventricle; in 2 patients the catheter ended in the parenchyma (Table 1).

Patient cohort	
Number	146
Number of procedures	146
Age	50.2
Sex	51.3% males, 48.7% females
Diagnosis	
Normal pressure hydrocephalus	62
Post-infection	33
History of trauma	35
Cyst	7
Other	9
Number of malpositioned catheter	28 (19.2%)
Catheter crossed the midline	26
Catheter in the parenchyma	2

Table 1

In all cases, brisk CSF flow was reported after placement of the catheter, except in the two cases in which the catheter ended in the parenchyma (those patients underwent revision procedures). There were no neurologic complications observed from malpositioned catheters. The mean intracranial length of the catheter was 70 mm; mean distance from the burr hole to the midline was 29 mm, and the mean distance from the burr hole to the supra-orbital ridge was 113 mm. (Table 2).

	Intracranial catheter length (mm)	Distance from the burr hole to the midline (mm)	Distance from the burr hole to the supra-orbital ridge (mm)
Mean	70	29	113
Median	72	29.5	112
Maximum	90	42	156
Minimum	50	16	91

Table 2

We observed a clear correlation between the length of the intracranial catheter segment and the incidence of malpositioning of the catheter tip.

In fact, only 7% of all the catheters that were shorter than 75 mm crossed the midline, whereas 41% of the catheters that were more than 75 mm crossed the midline, ending in the contralateral ventricle (Table 3).

Intracranial catheter lenght	Number of ventriculostomies	Number of cases crossing the midline
< 55 mm	13 (9%)	1 (25%)
55 – 65 mm	52 (36%)	2 (3,3%)
65 – 75 mm	35 (24%)	4 (11,1%)
> 75 mm	46 (31%)	19 (41%)

Table 3

Among 26 patients who displayed an intracranial catheter malposition, we observed 5 cases of scaphocephaly, which corroborates the inevitable insuitability of the Ghajar guide in patients with craniosynostosis. For illustration purposes, we show the CT scan of patient with scaphocephaly that had the intracranial catheter translocated to the contralateral ventricle. Figure 3. illustrates the final position of the catheter in the contralateral ventricle. A theoretical calculation was developed to assess this observation.

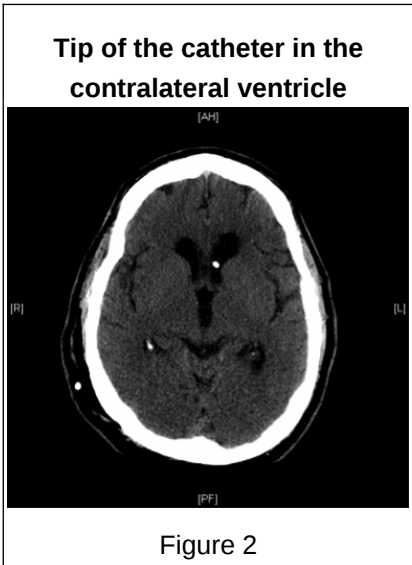


Figure 2

Conclusions

The importance of this retrospective study is to reassess the precision and validity of Ghajar guide in aiding in the positioning of a catheter tip to the Foramen Monroi; Our results demonstrate, that the Ghajar guide is only a suitable tool, if a) the entry point is adequately chosen b) the catheter length is appropriate and c) the patient's anatomy is of a normative type. In cases in which the patient has an anatomical variant or deformity or whenever the anatomy of the ventricles is distorted (e.g. due to bleeding or tumors), the device is not suitable for guiding the catheter towards the intended target point. Meticulous attention needs to be paid to the placement of an accurate burr hole. In cases of infrequently encountered anatomical variants or deformities, such as metopic craniosynostosis, the device is also not suitable for guiding the catheter towards the intended target point. An important correlation was found between catheter tip malpositioning and excessive intracranial catheter length. We could demonstrate, that if the length of the intracranial catheter segment exceeds 75 mm the rate tip malpositioning increases significantly to nearly 40%.

We can thus conclude, that the Ghajar guide is an accurate placement aide in patients with normative (conventional type) type and without any distortion of the ventricular anatomy. The entry point of the catheter is pivotal for a successful placement of the tip in the intended place.