The Reliability of the “Absent Cistern Sign” in Assessing LP Shunt Function

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ABSTRACT: ***Objective:*** One of the difficulties with lumboperitoneal (LP) shunts has been non-invasively ascertaining shunt function. It has been previously reported that in the presence of a functioning LP shunt the perimesencephalic cisterns become obliterated – the “absent cistern sign”. In order to more rigorously test this association we performed a retrospective analysis of LP shunt patients at the Hospital for Sick Children, Toronto. ***Methods:*** The CT scans of all patients undergoing LP shunting over a 17 year period were reviewed. The “absent cistern sign” and ventricular size were compared against the results of either an isotope shunt study or surgical findings performed within 2 days of the CT. ***Results:*** There were 38 CT scans (27 patients) performed within 2 days of an isotope shunt study and 15 CT scans (14 patients) performed within 2 days of a surgical intervention. These results give the absent cistern sign a sensitivity of 75% and a specificity of 57% when compared to the shunt isotope findings and a sensitivity of 100% and a specificity of 50% when compared to the surgical findings. Over 30% of the CT scans showed ventriculomegaly in the presence of a functioning shunt and, conversely, nearly 45% of the CT scans had normal or small lateral ventricles in the presence of a malfunctioning shunt. ***Conclusions:*** The “absent cistern sign” appears to reliably rule out a completely blocked shunt, but is less reliable in detecting a normal or partially obstructed shunt. Ventricular size correlates poorly with LP shunt function.

RÉSUMÉ: Fiabilité du signe de la citerne absente dans l’évaluation du fonctionnement d’une dérivation LP. ***But:*** Une des difficultés associées aux dérivations lombopéritonéales (LP) est de s’assurer de façon non invasive que la dérivation fonctionne. On a rapporté antérieurement que les citernes périmésencéphaliques sont oblitérées en présence d’une LP fonctionnelle – le “signe de la citerne absente”. Nous avons effectué une analyse rétrospective des cas de patients ayant une dérivation LP au *Hospital for Sick Children* à Toronto afin d’évaluer de façon plus rigoureuse cette association. ***Méthodes:*** Nous avons revu les tomodensitométries de tous les patients qui ont subi une dérivation LP sur une période de 17 ans. Le “signe de la citerne absente” et la taille ventriculaire ont été comparés aux résultats soit d’une étude isotopique de la dérivation ou aux observations chirurgicales obtenues dans les 2 jours suivant la tomodensitométrie. ***Résultats:*** 38 tomodensitométries ont été effectuées (27 patients) dans les 2 jours d’une étude isotopique de la dérivation et 15 tomodensitométries (14 Patients) dans les 2 jours suivant une intervention chirurgicale. Ces résultats confèrent au signe de la citerne absente une sensibilité de 75% et une spécificité de 57%, par rapport aux observations obtenues par l’étude isotopique et une sensibilité de 100% et une spécificité de 50% par rapport aux observations obtenues à la chirurgie. Plus de 30% des tomodensitométries montraient une ventriculomégalie en présence d’une dérivation fonctionnelle et, à l’inverse, près de 45% des tomodensitométries montraient des ventricules latéraux normaux ou petits en présence d’une dérivation défectueuse. ***Conclusions:*** Le “signe de la citerne absente” semble éliminer de façon fiable une dérivation complètement obstruée, mais il est moins fiable pour mettre en évidence une dérivation normale ou partiellement obstruée. La taille ventriculaire est faiblement corrélée au fonctionnement d’une dérivation LP.

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Although lumboperitoneal shunts are being used with decreasing frequency, one of the difficulties that remains is in non-invasively assessing shunt function in those who have had prior LP shunt placement. In 1986, Chuang et al. noted the obliteration of the basal cisterns on computed tomography (CT) – the “absent cistern sign” – to be a reliable indicator of LP shunt function and, conversely, the presence of basal cisterns to correlate well with shunt malfunction.[1] We, therefore, decided to confirm this finding by performing a retrospective review of all the available CT scans on patients who had undergone insertion of an LP shunt at the Hospital for Sick Children over a 17 year period. The CTs were compared to the most accurate assessment of shunt patency currently available (radionuclide shunt study[2] and operative findings) in order to truly assess the reliability of the “absent cistern sign”.

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METHODS

Patient Population

Of 143 patients in whom a lumboperitoneal shunt was initially inserted at the Hospital for Sick Children, Toronto, Canada between 1974 and 1991 there were 101 in whom follow-up CT scans were available for review. Out of a total of 309 CT scans, there were 53 CT's in 36 patients performed within 2 days of a surgical revision or a radionuclide shunt isotope study and only these were included in the study. Those patients in whom there had been posterior fossa surgery (8 tumors) or in whom there was evidence of incidental pathology at the level of the basal cisterns (1 arachnoid cyst) were excluded from the neuroimaging analysis.

There were 23 males and 13 females and the mean age at first insertion was 3.0 years (range 2 months to 17.7 years). The indications for shunting were: communicating hydrocephalus (83.3%); pseudotumor cerebri (2.8%); CSF fistula (2.8%) and miscellaneous pathology (11.1%). The mean follow-up time period was 9.1 years (range 49 days to 16.9 years).

At the time of initial shunt placement, 31 patients underwent insertion of a T-tube shunt via a limited laminotomy and 5 patients had their shunt inserted by the percutaneous technique using a Touhy needle. All the T-tube shunts were silastic and at the time of initial insertion incorporated medium pressure distal slit-valves (apart from 2 patients in whom low pressure distal slit-valves were used). In the percutaneous group, 1 of the shunts was valveless polyethylene and this was converted to the silastic type at first malfunction. The remainder were distal slit-valve unishunts.

CT Analysis

All available CT scans were analyzed and the degree of obliteration of the perimesencephalic cisterns and the size of the lateral ventricles were noted. The basal cisterns were classified as open, if a hypodense cerebrospinal fluid space was seen to delineate the quadrageminal plate region, or closed, if no such space was seen (Figure 1). The lateral ventricles were classified as small, normal or enlarged. All the imaging was reviewed by a neuroradiologist who remained blinded to the clinical state of the patients or the results of the isotope shunt study or surgical findings.

The CT scan results were subsequently correlated to either the operative findings at the time of shunt malfunction or to the findings from isotope shunt studies. Operative findings were recorded as demonstrating either drainage or no drainage of CSF. Isotope shunt studies were recorded as either normally functioning or malfunctioning (which included obstructed and partially obstructed shunts, defined as a patent shunt with slow flow).

RESULTS

There were 38 CT scans (27 patients) which were performed within 2 days of an isotope shunt study and Table 1 displays the correlation between the perimesencephalic cisterns, size of lateral ventricles and the shunt-study findings. Similarly, there were 15 CT scans (14 patients) performed within 2 d ays of a surgical intervention and these data are shown in Table 2. These results give the "absent cistern sign" a sensitivity of 75% and a specificity of 57% when compared to the shunt isotope findings and a sensitivity of 100% and a specificity of 50% when compared to the surgical findings. There were 6 false positives of the "absent cistern sign", i.e., open cisterns in the presence of a functioning shunt, when compared to isotope study and 3 when compared to surgical findings. There were also 6 false negatives, i.e., absent cisterns in the presence of a malfunctioning shunt, when compared to isotope study but none relative to surgical findings. It should be noted that in all the false negative cases the obstruction was only partial and in

A

Figure 1: (A) Axial CT scan showing closed basal cisterns, the "absent cistern sign", in the presence of a functioning LP shunt.

B

Figure 1: (B) Axial CT in the same patient showing open basal cisterns due to LP shunt malfunction.

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Table 1: Relation of Basal Cisterns and Ventricle Size to Isotope Shunt Study (n = 38).

	Shunt Study Findings	
	Malfunctioning	Normally Functioning
Cisterns		
open	18	6
closed	6	8
Ventricles		
small	3	4
normal	8	5
large	13	5

Table 2: Relation of Basal Cisterns and Ventricle Size to Surgical Findings (n = 15).

	Surgical Findings	
	No Drainage	Drainage
Cisterns		
open	9	3
closed	0	3
Ventricles		
small	1	1
normal	3	3
large	5	2

no case were absent cisterns recorded in the presence of a complete shunt blockage.

The positive predictive value of the "absent cistern sign", i.e., the probability of shunt malfunction in the presence of open cisterns, was 75% when compared to both the shunt study and surgical findings.

Review of the size of the lateral ventricles confirms the difficulty in using this parameter to determine LP shunt function with 36% and 33% of the CT scans showing ventriculomegaly in the presence of a functioning shunt as determined by isotope study and surgical findings, respectively. Conversely, 46% and 44% of the CT scans demonstrated normal or small lateral ventricles in the presence of a malfunctioning shunt by shunt study and surgical findings, respectively. In fact, of the 14 CT scans with an absent cistern sign, ventriculomegaly was found in 7 (50%). Of these, there were 3 patients (all of whom had studies to confirm the communicating nature of their hydrocephalus) with CT scans showing the absent cistern sign and ventriculomegaly in association with a small or non-visible IV ventricle (Figure 2).

Discussion

Although a relatively simple procedure, the use of lumboperitoneal shunts has been associated with many worrisome complications that, in recent years, have limited its indications and use.[3-5] However, there are still many patients with LP shunts in place who present with symptoms of potential shunt malfunction and the present experience with them may be limited. One of the difficulties of LP shunts has been accurately assessing shunt function as alteration in ventricular size on CT appears to be a rather imprecise and late development. It is with these factors in mind that the present study was performed.

Gilday et al. reported on the successful use of intrathecal ^{111}In-DTPA radionuclide to assess shunt patency.[2] Others have tried intrathecal contrast.[6] The non-invasive thermosensitive technique involving the cooling of the skin over the proximal shunt tubing and measuring the temperature drop distally to confirm

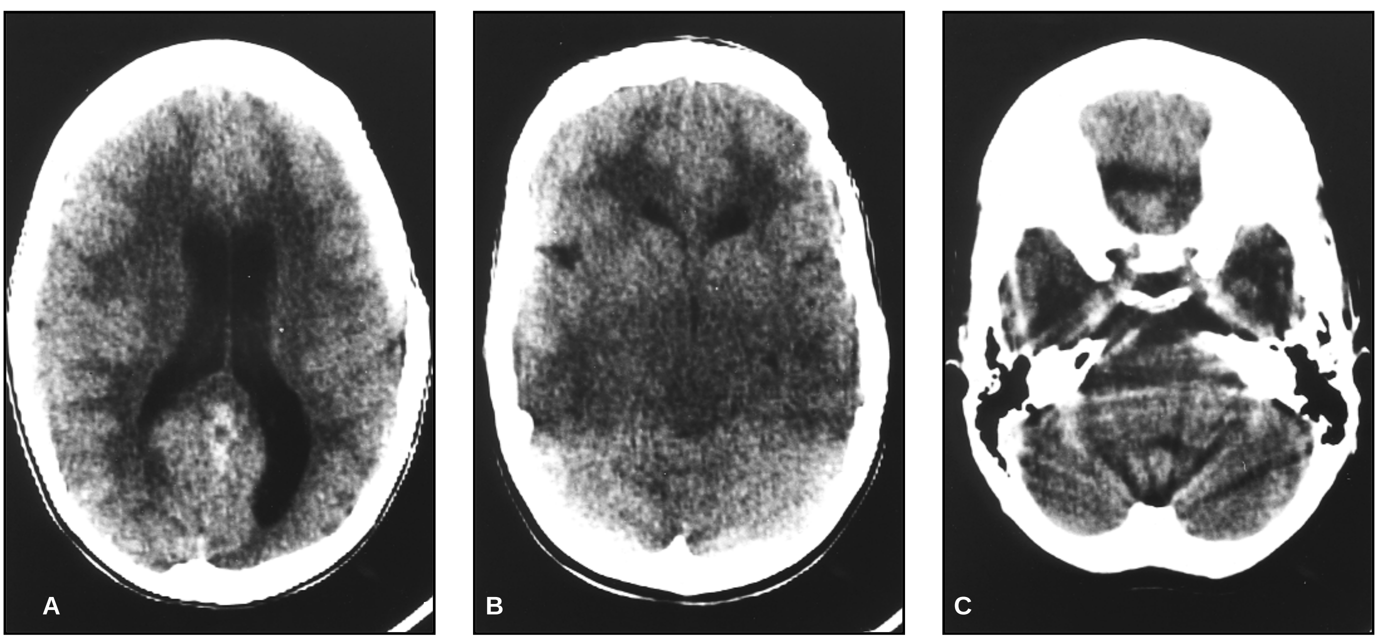

***Figure 2:** Serial sections of an axial CT scan in a LP shunt patient showing simultaneous ventriculomegaly (**A**), absent basal cisterns (**B**), and a small fourth ventricle (**C**).*

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shunt patency has also been described.[7,8] Schutz et al. reported the use of the lumbar infusion test in which the CSF pressure change is recorded during the infusion of artificial CSF into the lumbar subarachnoid space.[9] A blocked shunt would result in a precipitous pressure rise while this should not occur with a patent shunt.

In 1986, Chuang et al. described a non-invasive, simple CT sign – the obliteration of the perimesencephalic cisterns (“absent cistern sign”) – to be a reliable indicator of LP shunt function and, conversely, the presence of an open cistern to correlate well with shunt malfunction.[1] In that study 26 of 28 CT scans in asymptomatic patients showed the absent cistern sign while 18 of 20 CT scans in patients requiring shunt revision had visible basal cisterns. Their study data would give the “absent cistern sign” a sensitivity of 90% and a specificity of 93%.

In the present study the “absent cistern sign” also appears to be a very sensitive indicator of shunt malfunction, with values of 100% and 75% when compared to surgical and shunt study findings, respectively. However, the relatively low sensitivity when compared to isotope study was due to 6 false negatives that were all associated with obstructions that were only partial in nature. Therefore, the absence of cisterns on CT very strongly rules out the possibility of complete, but not partial, shunt obstruction.

Unfortunately, due to its specificity of 57% when compared to shunt study findings, the absence of cisterns on CT is less reliable as an indicator of a normally functioning shunt. While this study confirms that the absent cistern sign is a useful guide to LP shunt function, one must consider the significant false positive rate in normal shunts and the false negative rate in partially functioning shunts. Sound clinical judgment is required in interpreting this sign, which should not be used as the sole criterion for performing a shunt revision.

The data from the present study reveal the “absent cistern sign” to have a much lower specificity than had been shown by Chuang et al.[1] However, in their study a shunt was considered normal if the patient was asymptomatic and only a minority of these children had isotope shunt studies to confirm shunt patency. The present study was more rigorous in that all shunts that were classified as normal had shunt study confirmation. This may have altered our normal population since in all cases, for whatever reason, it was felt that a shunt study was indicated. As well, there is the question of how accurately isotope shunt studies assess true shunt function. In the series of Gilday and Kellam there were 2 false positives in a series of 74 LP shunts tested by this method.[2] Another possible explanation for the low specificity is the delay of up to 2 days between the CT scan and the shunt study or surgery. It has been suggested that intermittent blockage of the shunt tubing may cause transient visualization of the basal cisterns.[1] Change in shunt function between the time of the CT and isotope shunt study might result in a “false positive” finding in this study.

Ventricular size was found to correlate poorly with shunt function. Over 30% of the CT scans showed ventriculomegaly in the presence of a functioning shunt and nearly 45% demonstrated normal or small lateral ventricles in the presence of a malfunctioning shunt. Of interest is the finding that in 50% of CT scans with an absent cistern there was ventriculomegaly and in a small group of patients this ventriculomegaly was seen in association with a small fourth ventricle (Figure 2). This small group of patients had all had confirmatory studies establishing the communicating nature of their hydrocephalus prior to LP shunt insertion. This constellation of findings (ventriculomegaly, absent basal cisterns, and a small fourth ventricle) may indicate some degree of flow resistance within the aqueduct. It is possible that this may have occurred secondary to chronic LP drainage.

Conclusions

The “absent cistern sign” is reliable in ruling out the presence of a completely blocked LP shunt, but is less reliable in detecting shunts that are either functioning normally or are only partially obstructed. Ventricular size correlates poorly with LP shunt function. However, CT scan findings still require significant clinical correlation and, in many cases, can not replace more invasive, accurate methods of shunt function assessment.

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